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VOLUME 121

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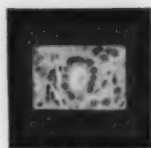
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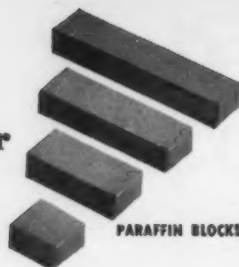
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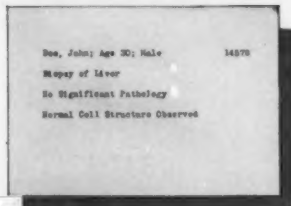


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Oxygen-Carrying Proteins: a Comparison of the Oxygenation Reaction in Hemocyanin and Hemerythrin with That in Hemoglobin

Irving M. Klotz and Themis A. Klotz

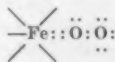
Department of Chemistry, Northwestern University, Evanston, Illinois, and
Marine Biological Laboratory, Woods Hole, Massachusetts

FOR the vast majority of organisms, oxygen in the atmosphere is one terminus of chemical metabolism. From the air oxygen becomes dissolved in water and then in blood, or enters directly into the blood, where the uptake is increased enormously when certain respiratory pigments are present. One hundred milliliters of sea water may hold about 0.5 ml of oxygen, whereas with oxygen-carrying pigments, 100 ml of blood may contain as much as 25 ml of oxygen.

These oxygen-carrying pigments are usually grouped into four classes: hemoglobins, chlorocruorins, hemocyanins, hemerythrins. Three of these contain iron at the center of the active site, but the fourth, hemocyanin, contains copper. Two of the iron-containing carriers, hemoglobin and chlorocruorin, have the metal centered in a porphyrin ring; however, the structure of the heme groups differs slightly in these two classes of protein. In the remaining two groups of pigment, pyrrole prosthetic groups do not occur, and it is likely that the metals are bound to a site whose configuration is determined by a constellation of amino acid side chains.

The uptake of oxygen is accompanied by a redistribution of electrons that produces changes in the colors of these pigments. With hemoglobin, these optical changes are relatively small shifts of certain spectroscopic absorption bands, but with hemocyanin and hemerythrin the color changes are profound. Neither of these last two proteins is colored in the nonoxygenated state; in contrast oxyhemocyanin is deep blue, oxyhemerythrin is dark violet-brown.

State of iron in hemoglobin and chlorocruorin. The nature of the electron distribution and the state of iron in hemoglobin has been established for some time, primarily from potentiometric (1) and magnetic (2) studies. In the nonoxygenated form, iron exists in the ferrous state; in oxyhemoglobin, the ferroheme group forms a complex with oxygen. The electronic structure of this complex may be written as follows (3).



The heme nature of the prosthetic group of chlorocruorin, as well as the general parallelism in behavior

of this oxygen carrier and hemoglobin, warrants the belief that the oxygenation reaction is of essentially the same character in both classes of protein.

State of copper in hemocyanin. The situation with hemocyanin and hemerythrin is more confusing, however. Largely by analogy it has been assumed that each metal is in its lowest valence state in the deoxygenated protein, cuprous in hemocyanin (4), ferrous in hemerythrin (5), and that this valence state is retained in the oxygenated proteins. With hemocyanin, however, there are difficulties with this viewpoint. The blue color of the oxygenated pigment is very reminiscent of the colors of simple cupric complexes. In fact the spectra of cupric-protein complexes prepared *in vitro* (6) (Fig. 1) generally show absorption maxima, at the proper pH, close to 600 mμ, which is the region of the maximum in the visible spectrum for hemocyanin. For some time it was difficult to account for the additional peak near 350 mμ shown by oxy-

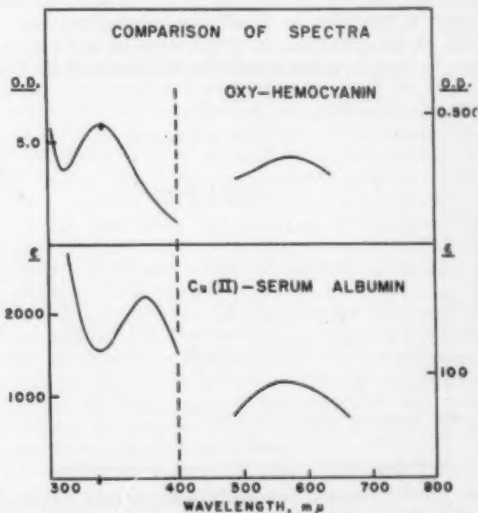


Fig. 1. Absorption spectra of oxyhemocyanin and of cupric-bovine albumin. O.D., optical density; ϵ , molecular extinction coefficient.

hemocyanin, but it has now been observed (7) that a cupric ion on the sulfhydryl group of serum albumin has an absorption maximum at 375 m μ . Thus the optical properties of oxyhemocyanin parallel those of cupric proteins (Fig. 1) and suggest that the metal is in the divalent state.

Nevertheless, the comparison of optical properties is not entirely convincing, for the intensity of absorption per gram atom of copper is 5 to 10 times greater in oxyhemocyanin than in the laboratory-prepared complexes. Evidently the copper in hemocyanin, even if cupric, must be in an unusual environment. For this reason we have looked for alternative methods of establishing the valence state.

Oxidation-reduction potentials have been measured by Conant, Chow, and Schoenbach (8), but as has been demonstrated by Rawlinson (9), the potentials drift over long periods of time, and it is likely that groups of the protein other than the metal are involved in these electrochemical reactions. Likewise an approach through magnetic measurements does not hold much promise, despite the substantial difference in the magnetic moments of cuprous and cupric ions (0 and 1.73 Bohr magnetons, respectively). For the copper content of hemocyanin is so small that a change in valence from +1 to +2 would change the mass susceptibility by only 0.03×10^{-6} per gram (9). Furthermore, the observed diamagnetism of the oxygenated protein (9) might be the result of the presence of cuprous ion combined with oxygen in which the two unpaired electrons have become paired, but it could also be explained in terms of copper in the cupric state with the free electrons of each pair of metal ions being coupled with the two unpaired electrons of a molecule of oxygen. Thus magnetic measurements lead to no decision about the state of the metal in hemocyanin. Finally, polarographic reduction of the metal ion, in which cuprous and cupric ions in complexes can usually be distinguished by the

appearance of one or two reduction waves, respectively (10), is also of no avail with hemocyanin. In the deoxygenated form no wave corresponding to either form of copper can be detected (Fig. 2); in oxyhemocyanin only the oxygen wave is observed (11). Evidently the copper, whatever its valence, is held very strongly by the protein, or is sufficiently imbedded in the macromolecule that the electrons from the dropping mercury electrode are unable to reach the metal ion.

We have turned back, therefore, to the use of specific quantitative color reactions. Examination of a number of possibilities has finally led to the adoption of 2,2'-biquinoline in glacial acetic acid. The glacial acetic acid (12) serves as an agent for the release of protein-bound copper and as an excellent solvent, both for the biquinoline and for the residual protein. The biquinoline gives a strong pink color with cuprous ion (13), none with cupric ion.

Application of this reagent to hemocyanin in the blood of the whelk (*Busycon canaliculatum*) gives results such as those shown in Table 1. We can see

Table 1. Application of 2,2'-biquinoline in glacial acetic acid to hemocyanin in the blood of the whelk (*Busycon canaliculatum*).

Metal	Nonoxygenated	Oxygenated
Cu(I)	$6.5 \times 10^{-4} M$	$2.9 \times 10^{-4} M$
Cu total	$7.5 (\pm 0.4) \times 10^{-4}$	

first that in the nonoxygenated protein, practically all of the copper is in the cuprous form. The deviation between the content of Cu(I) and total copper may be in part the result of the use of whole blood instead of crystalline hemocyanin and to the difficulty of removing the last traces of bound oxygen by a non-chemical method (14). Most striking and of greatest interest is the fact that oxygenation of hemocyanin converts approximately one-half of the copper to Cu(II), the remainder retaining the Cu(I) state. This observation has been confirmed many times with the dialyzed blood of *Busycon*, and comparable results have been obtained with the bloods of the lobster (*Homarus americanus*), squid (*Loligo*), and horseshoe crab (*Limulus polyphemus*).

Evidently, then, oxyhemocyanin contains copper in each of its two valence states, simultaneously. This information allows one to harmonize the confusing physicochemical results, particularly the spectra, previously described, and to draw a picture of the active site of the protein (Fig. 3), a picture that draws together all these data. Since the stoichiometry of O_2 to copper has been long known to be 1:2 (15), it is evident that one copper is cupric and one cuprous in the oxygen complex, as is illustrated in Fig. 3. The presence of some cupric ion would account for the blue color of hemocyanin. Furthermore the absorption peak near 340 m μ , close to that at 375 m μ of the cupric-sulfhydryl linkage in bovine serum albumin, suggests that the metal in hemocyanin is also

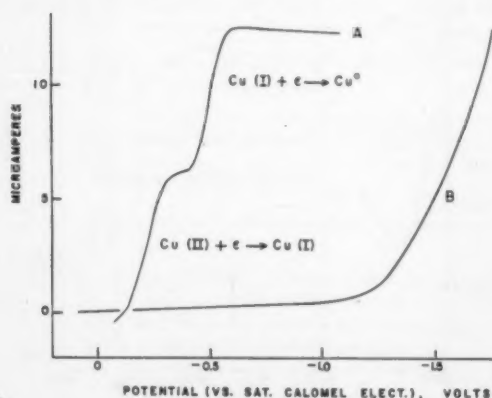


Fig. 2. (A) Polarogram of Cu(II) in aqueous ammonia solution; (B) of deoxygenated hemocyanin. The data for A were taken from Kolthoff and Lingane (10).

NON-OXYGENATED

OXYGENATED

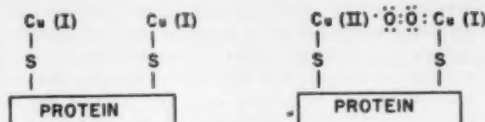


Fig. 3. State of copper in hemocyanin.

linked to the protein through a sulfur bridge. Of most significance are the very high extinction coefficients in oxyhemocyanin as contrasted to laboratory-prepared copper proteins, for enhancement of optical absorption is a definite characteristic of mixed valence states. One can point to familiar cases such as the ferrocyanides; but perhaps the most pertinent example is that of McConnell and Davidson (16), who prepared chloro-bridge complexes containing Cu(I) and Cu(II) and found decided optical exaltation as compared with the simple cupric complex.

Thus the oxygenation reaction in hemocyanin, in contrast to that in hemoglobin, involves also a partial oxidation reaction. The O_2 molecule picks up 1 electron from one of the two cuprous ions and becomes a perhydroxyl ion, O_2^- . The perhydroxyl radical has been demonstrated in aqueous solutions (17), and compounds such as KO_2 have been recognized for some time (18). In hemocyanin, some stabilization of this radical may also arise from possible resonance of an electron between the two copper ions.

State of iron in hemerythrin. In view of the success of a specific color test with hemocyanin, it seemed worth while to attempt an analogous approach with hemerythrin. Marrian (5) reported some years ago that the iron liberated from hemerythrin with dilute hydrochloric acid "gave a distinct Prussian blue coloration" with potassium ferriyanide. It would seem reasonable to conclude from this observation that Fe(II) existed even in oxyhemerythrin. However, the Prussian blue reaction does not lend itself to quantitative work. Without a quantitative check, Marrian's observation might be merely the result of a trace amount of Fe(II), as has indeed turned out to be the case; consequently we turned to other color tests for the valence state of iron.

Table 2. Application of o-phenanthroline with dilute sulfuric acid to a solution of crystalline hemerythrin (from *Phascolosoma gouldii*) in sea water.

Metal	Nonoxygenated	Oxygenated
Fe (II)	$1.24 \times 10^{-4}M$	$0.245 \times 10^{-4}M$
Fe total	1.67×10^{-4}	1.70×10^{-4}

The most convenient quantitative procedure has been to use o-phenanthroline with dilute sulfuric acid. Ferrous ion forms a characteristic orange color with reasonable rapidity in this solution (19). Application

of this reagent to a solution of crystalline hemerythrin (from *Phascolosoma gouldii*) in sea water gives results such as those shown in Table 2.

Turning to the oxygenated state first, we see that essentially all of the iron is in the ferric state (20). In contrast, in the deoxygenated protein, approximately two-thirds is ferrous, one-third ferric. Assuming that the stoichiometry (21) of O_2 to iron is 1:3, it is apparent that only 2 iron atoms change valence state in the oxygenation process. These results point to an active site with a configuration such as is shown in Fig. 4. Two of the irons in the nonoxygenated state, both ferrous, are evidently properly situated so that an O_2 molecule can fit in between them and pick up 1 electron from each, transforming the irons to Fe(III) and the oxygen to the peroxide ion, O_2^{--} . The third iron does not participate directly in the oxygenation reaction. Its function may be, therefore, to hold the other side chains together at a suitable distance apart.

NON-OXYGENATED

OXYGENATED

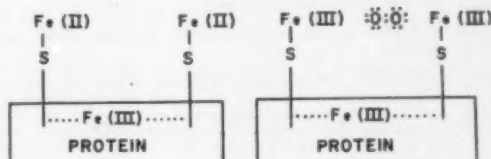


Fig. 4. State of iron in hemerythrin.

It is of interest that the intensity of absorption of hemerythrin is not greatly different from that of ferric-conalbumin (22). Thus the optical data conform with the specific color tests in indicating a single valence state, rather than a mixed Fe(II)-Fe(III) complex, in colored oxyhemerythrin.

As with hemocyanin, the attachment of the iron in hemerythrin is indicated as being through a sulfur atom. This assignment is based on the observation (23) that 1 mole of a mercurial is able to break up completely the oxygen-hemerythrin complex. Admittedly, mercury can combine with a great variety of protein side chains, but since its affinity for sulfur exceeds its affinity for any other ligand, it seems very likely that if only 1 mole of the metal is capable of affecting 1 mole of active site of the protein, the action comes about through the displacement of one of the iron atoms from a sulfur linkage to the protein. On the basis of the structure in Fig. 4, it seems reasonable that displacement from a sulfide linkage of either one of the two iron atoms holding the oxygen would destroy the stability of the complex and lead to the breakdown of oxyhemerythrin.

General conclusions. It thus seems clear that the nature of the oxygenation reaction is markedly different in hemocyanin and hemerythrin from that in hemoglobin. With this background the behavior of these proteins toward carbon monoxide becomes more

intelligible. The ability of carbon monoxide to combine with the iron of hemoglobin resides in its tendency to share a pair of its electrons just as oxygen does (3). To form stable complexes with hemocyanin or hemerythrin analogous to those with oxygen, the carbon monoxide would have to pick up 1 or 2 electrons, respectively; that is, it would have to act as an oxidizing agent, instead of as a reducing agent, which is its normal tendency. Thus a carbon monoxide complex with hemocyanin or hemerythrin would not be expected, in agreement with the most careful experimental observations (9, 21, 24).

From the viewpoint of the state of the combined oxygen, the three blood pigments may be arranged in a progressive series based on the stepwise change in the extent of reduction. Thus O_2 may be assigned to hemoglobin, O_2^- to hemocyanin, O_2^{--} to hemerythrin.

Such a progression makes the observed heats of oxygenation much more understandable. These fall in the order -8 kcal for hemoglobin (25), -13 kcal for hemocyanin (26), and -18 kcal for hemerythrin (27), all being compared on a common basis of dissolved oxygen as a reference state. It would be particularly difficult to account for the wide difference between hemoglobin and hemerythrin on the basis of the old assumption that the mechanism of the interaction of oxygen with Fe(II) is the same in both cases. On the other hand, the trend in thermodynamic properties conforms well with the interpretations derived from spectroscopic investigations and specific color tests.

Thus the nature of the electronic changes responsible for the color and oxygen-carrying ability of the proteins in all major classes of blood have now been elucidated.

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In the course of experience of many generations of students, I have known far more to fail from lack of grit and perseverance than from the want of what is commonly called cleverness.—J. J. THOMSON.

U.S. Geological Survey Radiocarbon Dates II.

Meyer Rubin and Hans E. Suess

U.S. Geological Survey, Washington 25, D.C.

RADIOCARBON dates of samples for which measurements were made in the laboratory of the U.S. Geological Survey from 1 May to 15 Oct. 1954 are listed in this article (1). Together with the first list of dates (2), this list presents the results obtained on 127 samples of previously unknown age during the first year of laboratory operation. The experimental procedure (3) and evaluation of the measurements have remained the same over the entire period of time, except that during June 1954 a complete set of new equipment that essentially duplicated the first set was installed and put into operation. Most of the samples listed were measured in both sets of counting equipment for a counting time of 1 day in each set. The ages given are weighted averages of the two measurements. Deviations in the results from the two sets correspond to those expected from statistics. Corrinne Alexander continued to assist in the preparation of the samples.

Our main efforts continued to be directed toward establishing an absolute time scale for the pre-Mankato substages of the last glaciation. Further evidence of the glacial advance on the North American continent around 20,000 yr ago was accumulated. The deposits representing this glaciation consist of at least most of the till of the Tazewell substage in Illinois and the drift called early Cary in Ohio. A glacial advance in the mountains of the western United States was determined to have occurred about 3000 yr ago. Evidence of a simultaneous continental glaciation was sought in Canada, but the results precluded such an episode.

As a different approach to the problem of the time

scale of the climatic fluctuations during the Wisconsin age, the dating of calcareous deep-sea sediments was begun by utilizing Foraminifera shells from cores for which the environmental temperatures of growth had been determined from the O^{18}/O^{16} ratios by Cesare Emiliani at the University of Chicago. This combination of methods leads to the most direct evidence of temperature variations with time. The preliminary measurements that have been carried out to date on core material from the Caribbean Sea show that after a long period during which water temperatures were about 5°C below those of the present, the temperature of the surface water in the Caribbean began to increase rather suddenly about 12,000 yr ago.

Further clarification of the picture of Recent climatic fluctuations can be expected from the dating of material bearing on sea-level changes, and, of even greater importance, by absolute correlations with well-established archeologic sequences in Europe, Asia, and Africa. A number of samples were included in this connection.

No absolute dates are given for samples found to be older than 32,000 yr. Although the carbon-14 determinations as such are sufficiently accurate to measure radiocarbon from samples as old as 45,000 yr, we feel that further work is necessary to substantiate the validity of radiocarbon dates in that range. For some measurements larger limits of error were given than usually assigned. These measurements were carried out at a time when an exceptionally high atmospheric radioactivity was observed. This activity caused a slight increase in the uncertainty of the background of the counters.

Radiocarbon Dates. (Age of each sample is shown in column 3, on the same line as the sample number in column 1. Discussion of samples appears in column 2.)

No.	Sample	Age (yr)
I.	<i>Samples with oceanic implications</i>	
	<i>A. Deep-sea sediments</i>	
	The sediments contained Foraminifera tests that had been investigated for O^{18} temperatures by Cesare Emiliani, University of Chicago. The paleotemperatures as a function of depth show a very good correlation in the two cores investigated so far by Emiliani. The purpose of the radiocarbon measurements was to find the rates of deposition and hence the temperature of the surface water at a given time. In most of the samples, the total carbonate of a core segment was utilized for the measurement. In two samples, however, only the coarse fraction with a grain size greater than $74\ \mu$, consisting mainly of Foraminifera tests, was used for the measurement. A comparison shows that the total carbonate probably contains a small fraction of material older than the Foraminifera. In addition, the presence of a small amount of	

No.	Sample	Age (yr)
	younger carbon, presumably incorporated by exchange with the atmosphere during the drying and handling of the core after sampling, results in an apparent age of about 35,000 yr. The coarse fraction of a deep sea core therefore seems more suitable for dating. Further measurements are in preparation and a complete discussion of the results will be published jointly with the other investigators at a later date.	
W-132	<i>Core 189</i> (Swedish deep-sea expedition 1947-48). Obtained from the Mediterranean Sea, lat. 33°54'N, long. 28°29'E, depth, 3664 m. The top of this core, approximately 0.4 m, was missing. W-132: 10 to 20 cm below upper end of core; W-133: 170 to 180 cm below upper end of core; W-148: 360 to 370 cm below upper end of core.	17,200 ± 500
W-133		Older than 32,000
W-148		Older than 32,000
W-160	<i>Core A 179-4</i> (Lamont Observatory). Obtained from the Caribbean Sea, lat. 16°36'N, long. 74°48'W, depth 2965 m. The material was prepared by and obtained from David Ericson, Lamont Geological Observatory, Columbia University, Palisades, N.Y. The ages are calculated using modern shells for the contemporary assay. W-160: total carbonate carbon from 0 to 10 cm below top of core; W-158: carbonate of the fine fraction only (grain size less than 74 μ) from 23 to 30 cm below top; W-159: same depth as W-158, coarse fraction only; W-134: total carbonate from 30 to 35 cm below top; W-164: total carbonate from 60 to 65 cm below top. W-162: coarse fraction only, from 70 to 77 cm below top; W-135: total carbonate from 150 to 155 cm below top; W-147: total carbonate from 260 to 265 cm below top.	3950 ± 250
W-158		13,500 ± 400
W-159		11,800 ± 300
W-134		15,700 ± 400
W-164		21,300 ± 800
W-162		27,600 ± 1000
W-135		Older than 33,000
W-147		Older than 33,000
	<i>B. Sea-level changes and strandlines</i>	
W-170	<i>Essendon, Victoria, Australia.</i> Wood from sewer-excavation works, corner Brunel St. and The Boulevard, taken with marine borers from black silt containing many marine shells. The collector, E. D. Gill, expected the sample to be younger than the Keilor Terrace (sample W-169 <i>Archeology</i>) and possibly correlated with the 10-ft strandline of Australia (see, however, sample W-185).	4820 ± 200
W-185	<i>Port Campbell, Victoria, Australia.</i> Shells of <i>Ninella torquata</i> from a well-developed bench 10 to 12 ft above the present strandline near Port Campbell in western Victoria. Collector, E. D. Gill, National Museum of Victoria.	Older than 30,000
W-195	<i>Port Fairy, Victoria, Australia.</i> Shells of <i>Ninella torquata</i> collected from the 25-ft beach at Port Fairy in western Victoria (see <i>Natl. Mus. Melbourne Mem.</i> 18). Collected by E. D. Gill.	Older than 35,000
II.	<i>Glacial samples</i>	
	<i>A. Ohio and New York</i>	
W-127	<i>Harrisburg, Ohio.</i> Log from deep road cut on a 1937 relocation of U.S. Highway 62 near Harrisburg, Darby Township, Pickaway County. The overlying till, probably 20 ft thick, contains sand lenses and is well back in the area mapped as early Cary drift by the submitter, R. P. Goldthwait, Ohio State University.	21,600 ± 1000
W-152	<i>North Hampton, Ohio.</i> Log from a creek cut exposing a "forest bed" 2½ mi west of North Hampton, Pike Township, Clark County. Submitted by R. P. Goldthwait.	Older than 40,000
W-166	<i>Streetsboro, Ohio.</i> Pieces of wood collected from peat in a deep cut along the new Ohio Turnpike 1 mi northwest of Streetsboro, Portage County. Peat deposit lies under about 12 ft of late Cary till and is underlain by gravel. According to the collectors, the deposit seems to have been a swamp, after early Cary time, which was overwhelmed by a late Cary ice advance. Collectors, G. W. White, University of Illinois, and J. Winslow, U.S. Geological Survey, Columbus, Ohio. W-184: because of the unexpected young age of sample W-166, another independent run was made.	8600 ± 300
W-184		8450 ± 250

No.	Sample	Age (yr)
W-188	<i>Sidney, Ohio.</i> Logs resting directly on well-zoned soil formed on top of more than 30 ft of till and buried by at least 20 ft of till. Exposure on cut along Baltimore and Ohio Railroad $2\frac{1}{4}$ mi south of Sidney, Shelby County, just east of the Miami River. Soil leached of carbonates to at least 4 ft with incomplete leaching to 6 ft and calcareous till above and below. Collected by Jane Forsyth, Ohio State University; submitted by R. P. Goldthwait.	$23,000 \pm 800$
W-198	<i>Edon, Ohio.</i> Wood fragments from glacial lake bed within the Wabash moraine. Section exposed in road cut at junction of Ohio Turnpike and State Highway 49, 6 mi north of Edon, Williams County, in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, T9S, R4W. Elevation approximately 980 ft. Section description, from top to bottom: (i) 6 ft gray silt, brown at top, stratified; (ii) 0.5 ft silt and clay with scattered wood fragments (sample horizon); (iii) 3 ft silt and fine sand, interbedded in thin layers; (iv) 4 ft bluish-gray till, clayey, exposed. The stratified silts are from a position necessitating the former presence of glacial ice to block the depression and form a lake. Collected by W. J. Wayne, R. P. Goldthwait, J. H. Zumberge, D. Eschman, and M. Rubin.	$14,300 \pm 450$
W-199	<i>Marilla, N.Y.</i> Wood from lake clays exposed in pipeline ditch $2\frac{1}{2}$ mi north of Marilla and 0.8 mi east of Town Line road on East Aurora quadrangle. Site is located between sand bar and beach strandline of glacial Lake Warren and is believed by collector to establish date for that lake stand. Section description, from top to bottom: Lake Warren sediments (i) 26 in. topsoil and clay loam, peaty near bottom; (ii) 2-in. peat layer; (iii) 6 in. clay, gray, red, and then yellow layer (sample W-199 was taken 4 in. from top); Lake Wayne sediments (iv) 8 in. silty sand, with clay patches. Collector, P. D. Blackmon, U.S. Geological Survey, Washington, D.C.	9640 ± 250
W-140	<i>B. Illinois, Indiana, Michigan</i>	
W-161	<i>Dyer, Ind.</i> Wood from beach deposits of the Glenwood stage of glacial Lake Chicago found 1 mi west of Dyer NE $\frac{1}{4}$ sec. 30, T35N, R15E, Illinois. Bretz states that the deposits of the Glenwood stage are late Cary. Section consists of lake sediments, a peat-and-wood horizon, and at the base a till. The lake sediments are from a late Glenwood spit that grew westward over the allocthonous peat and wood collected in a bay formed by an earlier and larger Glenwood spit that grew eastward. See ages of Libby's samples C-801, C-871, and C-872 (4). Collected by J. H. Bretz and L. Horberg, University of Chicago, and M. Rubin, U.S. Geological Survey, Washington, D.C.	$12,650 \pm 350$
	W-140: wood at peat horizon, underlying approximately 12 ft of lake sediments and above till; W-161: wood in sand and gravel stratigraphically above peat horizon.	$12,200 \pm 350$
W-165	<i>Greencastle, Ind.</i> Wood from silt horizon thought to be equivalent to the Farmdale loess (5). Collected in quarry 1 mi southwest of Greencastle, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, T14N, R4W, Putnam County. Section consists of 15 ft of till, $4\frac{1}{2}$ ft of silt (sample taken $2\frac{1}{2}$ ft from base), and 3 ft of Illinoian gumbotil resting on Ste. Genevieve limestone. Collector, C. L. Bieber, DePauw University.	$19,500 \pm 800$
W-167	<i>South Haven, Mich.</i> Wood lying immediately above a blue till near South Haven. Section consists of 40 ft of dune sand, 30 in. of peat, and 72 in. of bedded shallow lake sands with local dune sand, resting on blue till. The till surface is approximately at the surface elevation of Lake Michigan, 581 ft above sea level. This sample was run in collaboration with University of Michigan's C ¹⁴ laboratory, each laboratory arriving at a date independently. Michigan's sample M288a was dated $11,200 \pm 600$ yr (6). Collected and submitted by J. H. Zumberge, University of Michigan.	$10,860 \pm 350$
W-186	<i>Lake Bloomington Spillway II, Ill.</i> Wood from lower gray till exposed along spillway of Lake Bloomington, NW $\frac{1}{4}$ sec. 1, T25N, R2E, McLean County. This till underlies a boulder pavement that separates the lower till from the middle and upper gray till described under	$31,000$ or older

No.	Sample	Age (yr)
	sample W-67 (2). These gray tills underlie Bloomington and Normal till of Willman and Payne (7). Submitted by L. Horberg.	
W-187	<i>Farmdale Dam, Ill.</i> Wood fragment from lower 1 ft of Shelbyville till (20 ft), which is underlain successively by 2 ft of Iowan loess and 15 ft of Farmdale silt (5) on Illinoian till near Farmdale, SE¼ SE¼ sec. 36, T26N, R4W, Tazewell County. Collector, L. Horberg.	19,200 ± 700
W-126	<i>C. Iowa</i> <i>Mitchellville Section, Polk County.</i> Wood from loess underlying Cary till, NE¼ sec. 15, T80N, R22W. Sample was from lower woody horizon as described by collectors and should be similar to sample C-481 dated by Arnold and Libby as older than 17,000 yr (8). Section description, from top to bottom: (i) Cary till, 5 ft oxidized and leached; (ii) Iowan and Tazewell(?) loess, 3 ft oxidized and leached, 11 ft oxidized and unleached (upper sample horizon), and 15 ft unoxidized and unleached (lower sample horizon); (iii) road grade, State Highway 64. Collected by W. H. Scholtes, Iowa State College, and R. V. Ruhe, U.S. Department of Agriculture, Ames, Iowa.	16,720 ± 600
W-139	<i>Independence Section, Buchanan County.</i> Wood from pre-Iowan Wisconsin(?) silt, NW¼ sec. 3, T88N, R8W. Section description, from top to bottom: (i) 3 ft 2 in. Iowan loess; (ii) 6-in. pebble band; (iii) 5 ft 8 in. Iowan till, oxidized and leached; (iv) 2 ft Iowan till, oxidized and unleached; (v) 2 ft Iowan or pre-Iowan Wisconsin(?) leached, deoxidized silty clay; (vi) 1 ft Pre-Iowan Wisconsin(?) leached, black peat; (vii) 1 ft 9 in. Pre-Iowan Wisconsin(?) leached, unoxidized silt with abundant wood (sample horizon); (viii) 1 ft 6 in. Pre-Iowan Wisconsin(?) unoxidized and unleached till, exposed. Collected by W. H. Scholtes and R. V. Ruhe.	Older than 38,000
W-141	<i>Hancock Section, Pottawattamie County.</i> Wood from Farmdale loess of Leighton (5) on cut No. 33 on the Chicago, Rock Island, and Pacific Railroad relocation west of Atlantic, Iowa NE¼ sec. 23, T76N, R41W. Section description, from top to bottom: (i) 28 ft Wisconsin loess; (ii) 3 to 4 ft Farmdale loess, of which the A horizon consists of 18 in. of peaty, leached silt loam, black to dark gray, with abundant wood fragments (sample horizon) and the C horizon consists of 18 to 30 in. of leached gray to yellowish-brown silt loam; (iii) 15 ft Loveland loess, exposed. The Wisconsin loess above the Farmdale loess contains two faunal zones, the upper indicative of the Tazewell, the lower of the Iowan, according to the collector, R. V. Ruhe.	24,500 ± 800
W-153	<i>Clear Creek Section, Story County.</i> Wood from silt underlying approximately 10 ft of till along Clear Creek, NE¼ SW¼ sec. 5, T83N, R24W. Section described by R. V. Ruhe and W. H. Scholtes ["Radiocarbon dates in central Iowa," <i>J. Geol.</i> 63, 82 (1955)] and dated by Libby (sample C-528) as 16,367 ± 1000 yr. Collector, R. V. Ruhe.	14,700 ± 400
W-115	<i>D. South Dakota</i> <i>Brookings.</i> Spruce wood recovered from a depth of 138 ft in drift from a well drilled on the Harold Bruening farm, sec. 26, T110N, R48W, 12 mi east and 1 mi south of Brookings. Drill hole started in Iowan drift. Submitted by G. A. Avery, U.S. Department Agriculture, College Station, S.D., through R. F. Flint.	Older than 30,000
W-143	<i>E. Western United States</i> <i>La Sal Mountains, Utah.</i> Charcoal hearth from the lower part of an unnamed unit located SE¼ NE¼ sec. 22, T26S, R22E, at mouth of arroyo on east side of Pack Creek, ¾ mi downstream from dam in Spanish Valley. Believed by collector to be of post-Altithermal age and equivalent to Tségi formation (9) in Hopi County and Temple Lake glacial substage (10). This deposit, a reddish alluvium, can be traced upstream into outwash from moraine of Temple Lake substage. Collector, G. M. Richmond, U.S. Geological Survey, Denver, Colo.	2800 ± 200

No.	Sample	Age (yr)
W-145	<i>Long Draw, Cache La Poudre River, Colo.</i> Log from peat bog on type Long Draw (W ¹) substage of Bryan and Ray (11), deposits SW¼ SW¼ sec. 16, T6N, R75W, in saddle of La Poudre Pass, Rocky Mountain National Park quadrangle, Colo. A bog 10 ft thick formed in a depression on the hummocky Long Draw deposits. The log was taken from a position 18 in. above base of peat. Collector, G. M. Richmond.	6170 ± 240
W-200	<i>Castle Valley, Utah.</i> Charcoal from hearth in alluvium in lower Castle Valley, Utah, discovered in an excavation at Wolgamot Ranch, sec. 6, T25S, R23E. The hearth is 10 ft below the top of alluvium that is believed by collector to be correlative with the Tsegi formation (9), the Calamity formation (12), and the Piney Creek alluvium (13). Collector, C. B. Hunt, American Geological Institute, Washington, D.C.	1300 ± 250
W-190	<i>Unaweep, Colo.</i> Charcoal from a hearth in alluvium along East Creek, Unaweep Canyon, near State Highway 141 and 9.0 mi from its junction with U.S. Highway 50. The hearth is 6 ft below the top of the alluvium, which is believed to be correlative with the Tsegi-Calamity-Piney Creek alluvial series (9, 12, 13). Collector, C. B. Hunt.	1100 ± 250
<i>F. Canada</i>		
W-121	<i>Toronto Subway.</i> Woody material found in rapid transit excavation in stratified sands under upper till, near St. Clair Avenue, Toronto, Ontario. In the opinion of the collector, this peat is the same age as the famous Toronto interglacial horizon exposed in the eastern part of the city and thought to be Sangamon. Collector, A. K. Watt, Ontario Department of Mines. Submitted by R. F. Flint, Yale University.	Older than 30,000
W-130	<i>Cochrane I, Ontario.</i> Buried silty peat exposed in excavation cut on west end of bridge crossing Trans-Canada Highway, Frederick House River, west of Cochrane. Peat occurs at a depth of 30 ft and is apparently overlain by till; exposure was such that it is impossible to eliminate the possibility that the buried peat zone is overlain entirely by fill.	Less than 200
W-176	<i>Cochrane II, Ontario.</i> On Trans-Canada Highway ½ mi east of Frederick House River bridge crossing and just west of Cochrane. Samples taken from forest peat zones made up of stumps <i>in situ</i> and prostrate trunks and limbs. Section consists of 4 ft of peat resting on preglacial varved silts containing scattered pebbles. The samples from Cochrane were collected by T. N. V. Karlstrom, U.S. Geological Survey, specifically for the purpose of dating the "Cochrane" advance. Karlstrom, Rubin, and Suess are jointly preparing an article on this subject. W-176: from 2 ft below surface underlying a wood zone and a silty mossy peat; W-136: from 3½ ft below surface separated from upper sample horizon by mossy peat and from underlying varves by woody moss.	5300 ± 300
W-136		6380 ± 350
W-157	<i>Hillsborough, Nova Scotia.</i> Spruce wood from peat bed underlying stony and bouldery clay 1½ mi west of Hillsborough Church, Hillsborough, near Mabou, Cape Breton Island, Nova Scotia. Identical with sample Y-232 determined at Yale University to be older than 21,000 yr. Collected by L. R. Wilson, University of Massachusetts, and furnished by the Yale Geochronometric Laboratory.	Older than 38,000
W-177	<i>Plum Point, Ontario.</i> Larchwood found at Plum Point, north shore of Lake Erie, 10 mi west southwest of Port Stanley, 8 ft above the lake level in the "lower till." The same till covers the interstadial gyttja, sample W-100, <i>Port Talbot</i> , dated as older than 32,000 yr (2). Submitted by A. Dreimanis, University of Western Ontario, London.	27,500 ± 1200
W-189	<i>St. Pierre-les-Becquets Section, Quebec.</i> Wood from uppermost of three organic layers separated by silty sand in a section approximately 110 mi downstream from Montreal on the south shore of the St. Lawrence River, 1 mi along Provincial Highway 3 southwest of the village St. Pierre-les-Becquets and ¼ mi up a creek from the highway. Organic layer is about 76 ft down, underlying a very thick varved silt and clay section. Three feet of silty sand and silt are exposed under the bottom	Older than 40,000

No.	Sample	Age (yr)
	organic layer. In nearby sections this bottom silt is underlain by a red till, and the varves are overlain by a gray till. Indebted to N. R. Gadd, Canada Geological Survey, Ottawa, and R. F. Flint for the sample.	
W-194	<i>Amber, Ontario.</i> A fragment of a ball of peat, found at a depth of 65 ft in a kame gravel deposit, Markham gravel pit, 1½ mi north of Amber (north of Toronto). Section consists of 10 ft of late Wisconsin till, 100 ft of stratified gravel, and Wisconsin till underneath. Pollen analysis by J. Terasmae indicates a composition corresponding to the upper Scarborough beds, but also to the Two Creeks forest beds. Submitted by A. Dreimanis.	Older than 34,000
	<i>G. Alaska</i>	
W-174	<i>Goose Bay.</i> Wood from organic silt and peat overlying iron-stained gravels and underlying drift near Goose Bay, north shore Kuik Arm. Sample W-77, which dated older than 32,000 yr (2) came from base of this 41-in. peat section; this sample, from the upper 6 in. of the section, was run to determine whether the top of the peat was within range of radiocarbon dating. Extended range of new equipment allows placing older limit on the sample and does not represent a reversal of sequence. Collected by T. N. V. Karlstrom.	Older than 38,000
W-175	<i>Kenai Lowland.</i> Wood from tidal bog exposed along the shores of Turnagain Arm, near Girdwood. Wood was from a tripartite forest zone overlying tidal silts presumed to be from a glacial minimum. The forests are believed to record a relatively low sea-level stand that was terminated by a period of higher sea level, during which the overlying tidal silts were deposited. Collector, T. N. V. Karlstrom.	700 ± 250
W-183	<i>Fairbanks wood.</i> Stump from top of muck section 30 ft thick that overlies 140 ft of loess and is stratigraphically under 20 ft of loess. May date end of muck deposition and start of the excessive loess deposition. Collected at Gold Hill, 7 mi west of Fairbanks by T. L. Péwé, U.S. Geological Survey, College, Alaska.	4020 ± 200
W-192	<i>Cape Deceit.</i> Spruce log from silt bluffs at east base of Cape Deceit, 1½ mi west of Deering. Wood is from under thick section of organic silts and is expected to date a warm period in northern Seward Peninsula. Collector, D. M. Hopkins, U.S. Geological Survey, Washington, D.C.	Older than 35,000
	<i>H. Europe</i>	
W-173	<i>Godarville, Belgium.</i> Peat lens at base of Younger Loess II, excavated from canal P. 34 near Godarville 35 km south of Brussels, resting on a gravel that contains Mousterian artifacts, Levalloisian flakes, mammoth, and rhinoceros remains. Submitted by J. de Heinzelin, Institut Royal des Sciences Naturelles, Brussels, through R. F. Flint.	Older than 36,000
III.	<i>Other geologic samples</i>	
W-112	<i>Mexico, D.F.</i> Bellas Artes core. Wood from depth of 31 to 32.5 m. In conjunction with W-50, which dated 4900 ± 250 yr (2), the date obtained was to be used for calibrating the remainder of the core, which is being analyzed palynologically. Collector, L. Zeevaert, Consulting Engineer, Mexico, D.F. Submitted by P. B. Sears, Yale University.	Older than 32,000
W-197	<i>Singletary Lake, N.C.</i> Peat and lake sediments from Singletary Lake, Bladen County. Sample is from middle organic layer of three such layers occurring in deposits of the lake. See also Arnold and Libby's samples, C-474, C-475, and C-476 (8, 14). Section details are described by the collector, D. G. Frey, Indiana University, in <i>Ecology</i> [32, 518 (1951)].	Older than 38,000
W-149	<i>Crane Key, Fla.</i> Core sample from peat layer 26 in. thick below 75 in. of pure calcilutaceous sediment. Taken on largest of Crane Keys, 222 ft east of western shore near middle of island, lat. 25°00'18"N, long. 80°37'03"W (U.S. Coast and Geodetic Survey chart 1250). Sample measured to determine rate of sedimentation. Collector, R. N. Ginsburg, University of Miami.	3300 ± 240

No.	Sample	Age (yr)
W-168	<i>Buck Run, Pa.</i> Log from top of gravel underlying 3 ft of silty flood-plain deposits on left bank of Buck Run (tributary of Brandywine Creek) 1 mi south of Ercildoun. Sample is a characteristic or "type" piece from the stratigraphic section found in numerous localities throughout the Middle Atlantic and parts of the South Atlantic region. Date on this suggests considerable stability of a very thin stratigraphic section (3 ft), representing a relatively long period of time. See M. G. Wolman, <i>U.S. Geol. Survey Profess. Paper No. 271</i> (in press). Collected by M. G. Wolman, U.S. Geological Survey, Washington, D.C.	1450 \pm 200
IV.	<i>Archeology</i>	
	<i>A. America</i>	
W-142	<i>Scripps service yard charcoal.</i> Charcoal exposed during excavations for a new building on the campus of the Scripps Institution of Oceanography, La Jolla, Calif., in a section of terrace fill, 13 ft below the surface of a midden. According to the collectors, C. L. Hubbs and G. F. Carter, the charcoal is probably of human origin, although no definite proof can be given at the present time for the occupation of this layer by man.	21,500 \pm 700
W-154	<i>La Jolla Canyon.</i> Shells and charcoal from a single large hearth just south of Scripps Institution, 30 m back from beach cliff. The materials are definitely of human origin and came from the same terrace fill as sample W-142, but the possibility of a more recent canyon cut and fill was mentioned by the collector at the time the samples were submitted. The dates show that the samples are indeed from this younger fill. Collected by C. L. Hubbs, University of California.	580 \pm 200
W-155	W-154: Shells, <i>Mytilus californianus</i> Conrad; W-155: Charcoal.	600 \pm 200
	<i>B. Europe</i>	
W-150	<i>La Colombière, France.</i> Ashy material from hearth No. 3 in trench 19 of the site near Poncin (Ain) in eastern France, excavated and collected in 1948 by H. L. Movius, Jr., Harvard University. The horizon rests immediately upon and is in part interfingered with sediments accumulated during the final depositional stage of the 20- to 23-meter terrace of the Ain River. It is believed that this terrace was formed during the Wurm II stage of glaciation. The material should date an Upper Périgordian (or Gravettian) occupation layer. The possibility of contamination could not be excluded because the top of the hearth lay only 35 cm below a surface deposit containing a great deal of charcoal and other debris from recent campers, and because modern roots were noticed 25 cm below the level of the hearth. Two determinations by J. L. Kulp <i>et al.</i> on samples from the same hearth gave ages of 13,400 \pm 400 and 15,500 \pm 700 yr. The radiocarbon dates are too young for archeologic interpretation and indicate that the material of the hearth is heterogeneous.	11,750 \pm 600
W-151	<i>Abri Pataud, Les Eyzies (Dordogne)</i> in southern France. Ashy material containing charcoal traces from basal hearth found at a depth of 30 to 40 cm below the top of the Black Layer in trench II (Sections X and Y). Archeologic horizon: Périgordian IV (Upper Paleolithic). Locality described by the collector, H. L. Movius, Jr., in <i>Archaeology</i> [7, 82 (1954)].	23,600 \pm 800
W-191	W-191: the result on sample W-151 was considered by the collector to be the most important single date ever measured for an archeologic locality in Europe and therefore a second independent determination was made on similar material, collected separately by H. L. Movius, Jr., from the same spot at the same locality.	24,000 \pm 1000
W-172	<i>Meiendorf, Holstein, Germany.</i> Lake deposit (gyttja) from the glacial kettle with Hamburgian implements of the important Meiendorf site, about 13 km northeast of Hamburg. Assuming that the organic part of the gyttja is relatively free of reworked secondary material, the sample should date the Meiendorf stage of the Hamburgian Upper	15,750 \pm 800

No.	Sample	Age (yr)
	Paleolithic (compare with sample W-93, 2). Collected and submitted by A. Rust, Ahrensburg, Holstein.	
	<i>C. Asia</i>	
W-179	<i>Shanidar Cave, Zagros Mountains, Kurdistan, Iraq.</i> The deposits of the cave extending to a depth of about 45 ft below the surface can be classified into 4 major cultural layers. The top layer, A contains material from modern to about Neolithic times; layer B contains material from Mesolithic and Gravettian cultures of the Upper Paleolithic; layer C contains material from a new culture period (Baradost) in the Near East that seems to be contemporaneous with Aurignacian of Europe; and layer D contains Mousterian material of the Middle Paleolithic. The three samples of earthy charcoal were collected and submitted by R. Solecki, Smithsonian Institution, Washington, D.C. W-179: this sample, from the lower part of the Upper Paleolithic layer B, should give an early date for the Zarzi culture in that area; W-178: from a depth of 10 ft below datum in square S3W1 in layer C, 2 ft below the contact of layers B and C, where a widespread hearth, indicating an occupational horizon, was found; W-180: from a depth of 15 ft in square S2W4 in layer C and from a hearth zone in an occupational horizon heavily charged with material about 2 ft above the contact of layers C and D.	12,000 ± 400
W-178		29,500 ± 1500
W-180		Older than 34,000
	<i>D. Australia</i>	
W-125	<i>Keilor Terrace, Victoria.</i> Two charcoal samples from aboriginal hearths found and submitted by E. D. Gill, National Museum of Victoria. These samples were expected to date the Keilor terrace and therefore the Keilor skull, previously believed by some workers to be the oldest remains of <i>Homo sapiens</i> ever found. However, the collector, E. D. Gill, expected the terrace to have formed during a relatively recent pluvial period, possibly contemporaneous with the Mankato, and the skull to be of about the same age. No charcoal has been found at the exact site where the Keilor skull was discovered, but there seems to be no reason to assume that the skull is substantially older than the hearths from which the samples were collected. W-125: relatively large pieces of charcoal collected from a number of hearths with bones and artifacts buried in the Keilor Terrace at Braybrook south of Keilor. The age suggests that the material was at least in part intrusive; W-169: charcoal from aboriginal hearth in Keilor Terrace collected from middle of terrace (vertically) at the east end, of a molding-sand quarry on the south bank of the river at Braybrook, Victoria, about 200 yd west (upstream) from where Millears Road crosses the river. According to the collector this material and the terrace are no doubt of the same age.	3010 ± 160
W-169		8500 ± 250

References and Notes

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News and Notes

Plant Physiology at the International Botanical Congress

To supplement the report of P. Dansereau [*Science* 120, 821 (1954)], a few paragraphs should be added with regard to the very active section 11, plant physiology. Judging by the volume of communications presented—408 printed pages—this section was undoubtedly the largest at the congress and probably not less than double the size of any other. Section 11 was divided into three subsections dealing with physiology of nutrition, physiology of growth, and physiological ecology, respectively. In each subsection, the papers were grouped, insofar as possible, into symposiums, and many of the contributions had been specifically invited, in consultation either with the chairman or the *rapporteur-général* of each symposium.

The following list of topics on which symposiums were held, each with one or more general reports and from five to 20 communications, gives some idea of the breadth of coverage. The *rapporteurs*, who as a rule presented a critical summary of recent developments, are noted in parentheses.

- 11a: Photosynthesis (R. Emerson; K. Clendenning)
Organic acid metabolism (M. Thomas)
Biogenesis of secondary substances (K. Paech; R. David and C. Dagan)
Nutrition and mineral deficiencies (E. J. Hewitt; D. I. Arnon; T. Wallace)
Plant analysis and problems of fertilizers.
This was a special colloquium, running to seven sessions, held under the presidency of H. Lundegårdh and concluded with a summary by P. Prévot.
- 11b: Growth correlations in relation to humoral processes (K. V. Thimann)
Mechanism of action of auxin (L. J. Audus)
Growth inhibitors (H. Burström)
- 11c: Soil and water absorption (A. H. Hendrickson and F. J. Viehmayer)
Drought resistance (O. Stocker)
Frost resistance (B. J. Luyet)
Vernalization (G. Melchers)
Photoperiodism (S. J. Wellensiek, J. Diiörenbos and O. deZeeuw)
Temperature and thermoperiodism (G. Melchers; F. W. Went)
Physiology of fruits (J. Nitsch; J. A. Pearson and R. N. Robertson)

Smaller groups of papers, without a *rapporteur-général*, were given on nitrogen nutrition, mechanism of pathological growth, action of herbicides, and phasic theory of development. There were also some good joint meetings with other sections. Particular mention should be made of the joint meetings with the section on morphology, in which a special colloquium on gradients, organized by H. C. J. Prat, and a fine and very well-illustrated session on submicroscopic anatomy (A. Frey-Wyssling) held the attention of many physiologists. In addition, the small section 12,

agronomic botany, with about 20 papers, was largely devoted to physiology, and section 19, mycology, had a subsection for physiology of fungi. This included symposiums on *The Causes of Formation of Fruiting Bodies* (L. E. Hawker), *Fungal Pigments* (G. Smith), and the *Action of Growth Factors* (W. H. Schopfer).

In all of these symposiums extensive time was allowed for discussion—sometimes nearly as much time as for the papers themselves. Since in many cases one could read at least a summary of the paper beforehand in the printed proceedings, it was possible to develop a number of really well-informed and extensive discussions. The discussion on growth inhibitors, under section 11b, covering auxin antagonists, metabolic inhibitions, and accumulation phenomena, was particularly wide ranging and uninhibited. This leisurely turning over of the subject, equivalent to thinking aloud about it, helped to digest a good deal of what would otherwise have been an overwhelming mass of material. At an international congress, where colleagues meet only every few years, such an opportunity is, of course, especially valuable, but one could not help thinking how much the AIBS and AAAS meetings would be improved if similar time were made available.

Presumably all or most of these discussions, which were written down immediately afterward by the participants and assiduously collected by the section secretaries, will be published in due course. It is understood that the supplementary proceedings of the congress, containing discussions, papers sent in late, and speeches at the plenary sessions, will be published early this spring. They are said to run to some 2000 pages.

From the general tenor of the papers presented, it was evident that the large majority of workers are concerned with three topics: photosynthesis, mineral nutrition, and auxins. Emphasis was clearly on pure research, and the proportion of applied work reported at the congress appeared to be rather small. There is no reason to deduce, however, that only a small proportion of plant physiological research is of the applied type; the contrary is probably the case, and the emphasis on pure research is undoubtedly the result of the element of selection mentioned earlier, and because such work is cared for by international congresses of horticulture, crop protection, or forestry.

A feature of the congress was the presence of a large and active group from Russia, several of whom, including Academician Kurssanov, were physiologists. In striking contrast to the situation in previous years, these men were very willing, within the limitations imposed by language, to enter freely into discussion and conversation.

An event of potential importance was the founding of an International Society for Plant Physiologists. Following a special meeting to discuss the matter, a committee, consisting of Bennet-Clark (Great Bri-

tain), Bouillenne (Belgium), Burström (Sweden), Geiger-Huber (Switzerland), Thimann (U.S.A.), and Ulrich (France), drew up a provisional proposal for such a society. Membership is to be primarily on an individual basis, with a very small subscription fee (probably not over \$0.50 or its equivalent), and the maximum degree of cooperation with existing national societies is envisaged. For the present, M. Geiger-Huber (Botanical Institute, University of Basel, Switzerland) has agreed to act as general secretary. This society is intended to promote international contacts and understanding among physiologists, and it should improve the representation of physiology at international congresses; the society will be eligible to receive support from UNESCO or its counterparts for organizing small international symposiums on special topics. A resolution of support and cooperation with this society was passed by the American Society for Plant Physiologists at its September meeting at Gainesville, Florida, and the matter is to come before the Society for Experimental Biology (Great Britain) and the Scandinavian Society for Plant Physiology within the next few months. It is interesting to add that on 22 January a new national group, the Société de Physiologie Végétale, was founded in Paris by an enthusiastic group representing most parts of France. The stimulus provided by the proposed international organization played a definite part in the initiation of the French group.

It seems safe to conclude that plant physiology is rapidly coming into its own as an independent science of major importance.

KENNETH V. THIMANN

Biological Laboratories, Harvard University

Science News

Detlev W. Bronk, president of the National Academy of Sciences, announced 28 Mar. the appointment of a committee formed in response to the request of the Administration that the academy counsel with the Government on its policy with regard to relationships between questions of loyalty and the awarding of Government grants and contracts in support of unclassified research.

Chairman of the committee is J. A. Stratton, vice president and provost of Massachusetts Institute of Technology. The other members are Robert F. Bacher, director of Norman Bridge Laboratory of Physics and chairman of the division of physics, mathematics, and astronomy, California Institute of Technology; Laird Bell, Chicago attorney and director of numerous industrial and educational organizations; Wallace O. Fenn, professor of physiology, School of Medicine and Dentistry, University of Rochester; Robert F. Loeb, professor of medicine, Columbia University; E. Bright Wilson, Jr., professor of chemistry, Harvard University; and Henry M. Wriston, president of Brown University.

The Administration asked the advice of the National Academy of Sciences in this matter in a letter from Sherman Adams, assistant to the President of

the United States, to Bronk that was previously made public [*Science* 121, 7A (11 Feb. 1955)].

The department of biochemistry and the graduate school of the University of Washington have postponed indefinitely the symposium on the molecular basis of enzyme action that was to have taken place this week. The scheduled speakers have withdrawn from the symposium in protest against the university president's disapproval of a recommendation that J. Robert Oppenheimer be invited to the university as a visiting lecturer. In a letter to President Henry Schmitz, seven of the scientists state:

The undersigned agreed many months ago to participate in a Symposium on The Molecular Basis of Enzyme Action to be held under the auspices of the Department of Biochemistry of the Medical School of the University of Washington, on April 7 and 8, 1955. Our decision to participate in this Symposium reflected our high regard for the stature of the Department of Biochemistry and for the scientific value of the proposed Symposium. All of us, in addition, have respected friends and colleagues on the faculty of the University of Washington.

Your recent decision to refuse to appoint Dr. J. Robert Oppenheimer as Walker-Ames visiting lecturer has disturbed us greatly. There can be no question as to Dr. Oppenheimer's scientific competence. His academic attainments are evidenced by his recent reappointment as Director of the Institute for Advanced Studies. We can only assume, that, although Dr. Oppenheimer's tenure of the Walker-Ames visiting lectureship would have had nothing to do with security matters, he was not invited because of the events surrounding the withdrawal of his security clearance by the Atomic Energy Commission. By this action, which overruled the recommendation of your faculty, it seems to us that you have clearly placed the University of Washington outside the community of scholars. As the strongest protest that it is in our power to make, we must, therefore, refuse with great reluctance to cooperate at this time in any official activity of the University of Washington. In taking this position, we wish to reaffirm our high regard for the Department of Biochemistry, and express our deep regret that it has become necessary to withdraw from a scientific meeting of great interest.

It is our earnest hope that the university administration through cooperation with the faculty, can make arrangements to prevent similar violations of academic freedom in the future, and thus restore the University of Washington to its rightful and respected position in the academic world.

The signers of the letter were Robert A. Alberty, associate professor of chemistry, University of Wisconsin; Konrad Bloch, professor of biochemistry, Harvard University; David E. Green, professor of enzyme chemistry, University of Wisconsin; Arthur Kornberg, professor of microbiology, Washington University; Henry A. Lardy, professor of biochemistry, University of Wisconsin; William H. Stein, member, the Rockefeller Institute for Medical Research; and Bert L. Vallee, biophysics research laboratory, Harvard University. According to the *New York Times* an eighth scientist who was scheduled to speak, Charles S. Hanes, professor of biochemistry

at the University of Toronto, indicated that he would not participate for similar reasons.

The board of directors of the AAAS, at its regular meeting on 21 Mar., unanimously decided to send a letter of inquiry to President Schmitz. The letter expressed the board's concern over the newspaper accounts of the affair and the harm done to the university and others concerned and asked whether factors were involved that had not been made public. In replying President Schmitz sent a copy of a statement he had made to the university senate on 3 Mar. His statement included the following passages.

... I used only the two official reports of the hearings and findings as I attempted to decide what to do. Those who have clamored for the "reasons" for my decision need go no further—but they will have to do the reading themselves. I might add that I cannot understand how anyone could consider himself prepared to discuss this issue who has not studied carefully the *Texts of Principal Documents of Personnel Security Board, General Manager and Commissioners* in the matter of J. Robert Oppenheimer, May 27 through June 29, 1954. ...

My decision not to invite Dr. Oppenheimer to lecture on the University of Washington campus was reached only after long and careful study of his governmental relationships. Having reached this decision, I do not plan to reconsider it. It does not have any bearing on Dr. Oppenheimer's capabilities as a physicist nor does it involve the question of academic freedom nor his right to express a viewpoint. ...

Much of this case has the appearance—I hope in my heart it is only the appearance—of an attempt to force an administrative decision by building up internal and external pressures. Any such thought or act is unworthy of a University, and I refuse to entertain the thought just as I trust that the act never was considered. But I am dreadfully sorry that all of this happened. ...

The Government informed the United Nations on 21 Mar. that it does not favor any action by the U. N. to **change the present calendar**. The United States made its position known in a note to the United Nations Secretary-General, Dag Hammarskjöld, who had asked all governments for their views on proposals to revise the existing calendar [*Science* 121, 281 (1955)].

The question of calendar reform is under consideration by the United Nations Economic and Social Council. At its 18th Session last July, the Council adopted a resolution requesting the Secretary General to obtain the views of members and nonmembers of the United Nations on "the desirability of calendar reform." The subject is on the agenda of the Council's resumed 19th Session, which convenes on 16 May. The United States reply stated in part:

... This Government cannot in any way promote a change of this nature, which would intimately affect every inhabitant of this country, unless such a reform were favored by a substantial majority of the citizens of the United States. ... There is no evidence of such support in the United States for calendar reform. Large numbers of United States citizens oppose the plan for calendar reform that is now

before the Economic and Social Council. Their opposition is based on religious grounds, since the introduction of a "blank day" at the end of each year would disrupt the seven-day sabbatical cycle.

Moreover, this Government holds that it would be inappropriate for the United Nations, which represents many different religious and social beliefs throughout the world, to sponsor any revision of the existing calendar that would conflict with the principles of important religious faiths.

This Government, furthermore, recommends that no further study of the subject should be undertaken. Such a study would require the use of manpower and funds which could be more usefully devoted to more vital and urgent tasks. In view of the current studies of the problem being made individually by governments in the course of preparing their views for the Secretary General, as well as of the previous study made by the Secretary General in 1947, it is felt that any additional study of the subject at this time would serve no useful purpose.

Discovery and synthesis of **carbamyl phosphate**, a chemical that is involved in the building up of such compounds as urea and nucleic acids in living matter, was announced 22 Mar. by the American Cancer Society. The work was done by three doctors at Massachusetts General Hospital, Boston. Fritz Lipmann and Mary Ellen Jones discovered the compound through enzyme studies, and Leonard Spector synthesized it.

The **floating ice island** in the Arctic Ocean, T-3, will be reoccupied by a party of three Air Force scientists next month. The purpose of the reoccupation is to continue scientific studies already started in the area between northern Canada and Greenland. The team plans to remain on T-3 until 1 Sept. The island was abandoned on 14 May 1954, when it floated to a point near the northern tip of Ellesmere Island. It was considered too close to a fixed weather station to be of value as a weather-reporting station.

T-3 is now in approximately the same position as it was last May, but the new party is interested primarily in scientific research. The scientists will study the island through surface and subsurface observations. They will obtain data on surface weather, solar radiation, and marine biology of the Arctic Ocean. They will also obtain data on the gravitational, magnetic, and oceanographic aspects of the island, ocean depths, and the character and thickness of the sea ice.

Reports of important **anthropological discoveries** at Choukoutien, North China, and at other locations in western China are described by Hallam L. Movius, Jr., Harvard University, in a recent issue of the *American Anthropologist*.

After a 12-yr interruption, digging has been resumed at Choukoutien in a search for remains of Peking man or other even older ancestors of modern man. Work is being conducted under sponsorship of the Chinese Communist government and under direction of the Laboratory of Vertebrate Paleontology of Academia Sinica. Five teeth of Peking man have been found. In addition an upper arm bone and a lower leg

bone that were unearthed before the Japanese invasion have been identified as remains of Peking man.

The discoveries in western China are the first fossilized human bones found there. Part of the skull of a 10-yr-old girl who lived in the late Pleistocene age was found by Pei Wenchung, a paleontologist well known in the West who has been identified with research on Peking man. The skull, which is believed to be of the *Homo sapiens* type, is probably more than 10,000 yr old. This is the first evidence that modern man lived in China so long ago. It is hoped that the skull can be dated accurately from the remains of walnut and oak trees found in the same strata of sand and fine gravel in which the human bones were located.

On 23 Mar. A. C. B. Lovell, head of the radioastronomy station of the University of Manchester at Jodrell Bank near Manchester, England, played before the Royal Society of Art a 10-in. recording of an intergalactic explosion that occurred when two galaxies of stars in the constellation Cygnus crashed 100 million years ago. The sounds were picked up by radio-telescopes. Some 2000 invisible stars have been added to Northern Hemisphere space charts as a result of research with radiotelescopes, and a new 250-ft paraboloid antenna is now under construction at Jodrell Bank.

Test pilots who participated 23 Mar. in a panel discussion, "Sky unlimited," that climaxed the 26th annual meeting of the Aero Medical Association at the Hotel Statler, Washington, D.C., reported that since they have passed the sound barrier they have run into "the lower edge" of a new barrier they call the "controllability barrier." The new barrier is reached at that point at which the speed of the airplane exceeds the capacities of the design of the controls. One of the pilots, Arthur Murray (major, USAF) said that when he exceeded 1400 mi/hr he lost control of the plane and did not regain control until after the craft slowed itself. Murray said that this "new barrier" to super-speed flight can be overcome by new designs for the planes of the future.

A description of nuclear research activities in the Soviet-occupied zone of Germany appears in the 17 Mar. issue of the *Bulletin*, a weekly survey of German affairs published by the Press and Information Office of the Bonn Government.

... At Berlin-Buch the Institute for Medicine and Biology has installed ... a plant generating a two million volt direct-current power-supply. It specializes in the production of isotopes and the deflection of electrons. The Research Institute for Solids experiments with radium and the measuring of radioactivity.

The Institute at Miersdorf near Zeuthen is said to be equipped with a two million volt direct-current plant and to work on nuclear fission problems and the production of isotopes. The protective screen against radioactive effects used at Miersdorf is said to be of Russian design: layers of coke and paraffin alternated with air cushions.

The Potsdam Observatory for Astro-Physics is en-

gaged in high altitude and atomic radiation research work. The research establishment K hlungsborn is working along the same lines. It is equipped with a betatron and is assisted in its research work by balloons and jet planes of Russian make.

It is assumed that the Institutes for Physics at the Universities of Halle and Jena are also engaged in nuclear research. At the latter, university work on developing a special betatron was taken in hand three years ago. Geiger counters are apparently manufactured at Radebeul in Saxony. A special department established at the Mining Academy of Freiberg, Saxony, is stated to have made some progress in research on the radioactivity of the various strata of the earth. An atomic reactor is said to be nearing completion at Aue, not far from the Soviet-operated uranium mines, on the Saxon-Czechoslovakian border.

Scientists in the News

The nomination of Kingsley Davis, director of the Division of Population Research at Columbia University, as United States representative on the United Nations' Population Commission has been confirmed by the Senate. The commission arranges population studies and advises the U.N. Economic and Social Council on such matters as technical-assistance activities in the field of population; relationships between population trends and economic and social factors; and plans for the preparation of standards of population censuses.

Ludwig Biermann, head of the astrophysics section of the Max Planck Institute of G ttingen, Germany, is spending several weeks this spring at the Strawberry Observatory, Haverford College, where, as a Philips visitor, he is delivering a series of lectures on cosmic magnetohydrodynamics.

The Samuel Sackett Foundation for the study of rheumatic fever and its related diseases has announced that Gene H. Stollerman has been chosen to direct rheumatic fever research in the department of medicine of Northwestern University Medical School. The research program was made possible by the income from a \$500,000 endowment providing for the research on a permanent basis. Well known for his contributions to the prevention of rheumatic fever, Stollerman is now medical director of Irvington House, a New York hospital devoted to the care and study of children with heart disease.

Before assuming his duties at Northwestern, he will spend a month in Europe, where he will address the European Congress of Rheumatology at The Hague and deliver lectures at the University of Paris.

J. S. Nicholas, Sterling professor, chairman of the department of zoology, and master of Trumbull College of Yale University, was honored as managing editor of the *Journal of Experimental Zoology* on the recent occasion of his 60th birthday, with the dedication to him of volume 129 of the journal. This volume, designated as the "Nicholas Festschrift," contains 26

papers contributed by his former students, colleagues in this country and abroad, and members of the editorial board. It was presented to Nicholas at the birthday celebration given by members of the Osborn Zoological Laboratory and attended by his colleagues and former students.

William C. Steere, editor-in-chief of the *American Journal of Botany* and member of the Stanford University faculty since 1950, has been appointed dean of the university's Graduate Division. He is currently on a year's leave of absence to serve as program director for systematic biology with the National Science Foundation.

In September he will succeed **Ernest R. Hilgard**, an expert in the field of conditioned learning. Hilgard is resigning the deanship because of his wish to give full time to teaching and research as professor of psychology at Stanford.

Henry B. Hass, president of the Sugar Research Foundation, will receive the 1955 honor scroll of the New York chapter of the American Institute of Chemists. The award will be presented during the annual meeting on 2 June at the Hotel Commodore. Best known for his work in aliphatic nitration, Hass has also done extensive research in activated carbon, chlorination, fluorocarbons, and compounds of pharmacological interest.

Gordon E. McCallum, sanitary engineering director of the U.S. Public Health Service, will head the service's water-pollution-control program. He will be succeeded in the post of chief of the Office of Health Emergency Planning by **John B. Hozier**.

In his new office, McCallum will head one of the most important sanitary engineering activities of the service, the water-pollution-control projects of which date back to 1912. The current program supports state projects for protecting the purity of the nation's water supply and works with states, interstate agencies, cities, and industries in attempting to keep pollution out of rivers and lakes.

Ernst Schmidhofer, formerly of the Veterans Administration Hospital in Jackson, Miss., has been appointed medical director of the Milwaukee, Wis., County Asylum. **Morris Gelfman** of the Veterans Administration Hospital at Downey, Ill., has also joined the staff, where he will serve as clinical director.

John Patterson, who retired from the position of controller of the Canadian Meteorological Service in 1946, has received the first Patterson medal, which is to be given annually to the Canadian resident who is judged to have made the most outstanding contribution through distinguished service to meteorology.

Patterson joined the Canadian Weather Service in 1910, where his inventive genius and organizing ability led to the design of a series of instruments able to perform under rugged weather conditions. His Pat-

erson barometer became the Canadian standard; the four-cup anemometer formerly used has been replaced by the present three-cup type, largely as a result of his studies. Although Patterson is internationally known for the many improvements he has made in meteorological instruments, he is best known in Canada for his long record of service as the country's leading weatherman. His work has been internationally recognized by the granting of life fellowships in both the Royal Meteorological Society and the American Meteorological Society.

Albert William Tucker, chairman of the department of mathematics at Princeton University, has been appointed to the Albert Baldwin Dodd professorship of mathematics.

Isamu Suda, a neurophysiologist and professor of physiology at the Kobe Medical School, Kobe, Japan, has been named visiting professor of physiology at the State University College of Medicine in Brooklyn for 1 yr, effective 1 Sept. While in this country, he will engage in neurophysiological research involving intracellular and extracellular recording of neuronal activity in higher and lower centers of integration within the nervous system.

At the recent meeting of the Cooper Union Alumni Association the Gano Dunn citation was awarded to **William Dubilier**, founder of the Cornell-Dubilier Electric Corp., for his contributions to radio and television communications and to electric power distribution. Dubilier has at least 400 patents to his credit, and his invention of the mica capacitor resulted in the establishment of his company, which now has more than 16 plants.

Gunni Larsson, head of the government experimental garden in Öjebyn, in northern Sweden, will arrive in New York in August. For 1 yr she will teach botany and horticulture at the Brooklyn Botanic Garden. George Avery, director of the garden, met Larsson in Öjebyn some years ago and became interested in her studies of the *Rubus* family, to which the raspberry and blackberry belong. Larsson comes to America on an Ellen Eddi Shaw teaching fellowship, which is granted to a foreigner only once a decade.

For his contributions to the use of acetylene, **Augustus B. Kinzel**, director of research for the Union Carbide and Carbon Corp., has received the International Acetylene Association's 1954 Morehead award. Kinzel has pioneered in the theory of stainless steels and the development of weldable alloy structural steels and of alloying metals.

Necrology

Lowell M. Alexander, 63, authority on the physics of electricity, sound, and acoustics, professor of physics at the University of Cincinnati College of Engineering, Cincinnati, Ohio, 22 Mar.; **Warder C. Allee**,

69, zoologist, professor and head of the University of Florida biology department, Gainesville, 18 Mar.; **Philip Burnett**, 77, former professor of clinical dermatology at McGill University, Montreal, 15 Mar.; **Edwin J. Cameron**, 59, food scientist, director of the National Canners Association Research Laboratories, Washington, D.C., 21 Mar.; **Elizabeth P. Donnan**, 71, author, professor emeritus and former head of the economics and sociology department at Wellesley College, Wellesley, Mass., 15 Mar.; **Evan M. Evans**, 85, diagnostician, retired director of the department of medicine at Roosevelt Hospital, retired professor of clinical medicine at Columbia University's College of Physicians and Surgeons, New York, 17 Mar.

John K. Flick, 70, retired civil engineer with the U.S. Bureau of Public Roads, San José, Costa Rica, 19 Mar.; **Frank C. Gates**, 67, botanist, author, past president of the Ecological Society of America, professor of taxonomy and ecology at the Kansas State College, Manhattan, 21 Mar.; **William F. Hewitt**, 60, former assistant professor of obstetrics at Rush Medical College, Chicago, Ill., 21 Mar.; **Josephine B. Neal**, 74, investigator in poliomyelitis, meningitis, and encephalitis, author, former clinical professor of neurology at Columbia University's College of Physicians and Surgeons, former director of the William J. Matheson Survey of Epidemic Encephalitis, New York, 19 Mar.; **Auguste J. Paris, Jr.**, chemical engineer, developer of a process for deriving gasoline from natural gas, Bradford, Pa., 22 Mar.; **Adolf Zeckel**, 50, associate in psychiatry at the Vanderbilt Clinic of the Columbia-Presbyterian Medical Center, New York, 17 Mar.

Meetings

The **European Convention for Chemical Engineering** to take place in Frankfurt-am-Main, Germany, 14-22 May, will include the following functions: 1955 Congress of the European Federation for Chemical Engineering; Achema XI Chemical Apparatus and Equipment Congress and Exhibition; 30th annual general meeting of the Dechema; special meeting and lecture convention of the German Chemists' Society; and special meeting of the German Electrical Engineers' Association.

The chemical engineering congress will be conducted by the 23 scientific and technical societies from 13 European countries that form the federation. Lectures will be delivered on apparatus; machinery raw materials and auxiliary materials used by chemists and chemical engineers; and chemical engineering processes and methods.

At a special meeting and lecture convention of the German Chemists' Society, honors will be conferred on distinguished chemists and chemical engineers, and four plenary lectures will be given. A special program for this event can be obtained from the Office of the Gesellschaft, GDCh-Geschäftsstelle, Grünberg (Hessen), Marktplatz 5, Germany.

In size and scope, the Achema XI will far exceed

all previous Achemas. Thirteen large halls will be needed for the exhibition by more than 750 firms from 12 different countries of thousands of pieces of machinery; chemical apparatus and equipment; regulating, measuring, and control equipment; and materials and auxiliary materials used in chemical science and industry.

The trilingual *Achema Year Book* and the 887-page *European Catalog of Chemical Apparatus and Equipment* will be supplied gratis to all congress participants registered in advance by name. For further information, write to Dechema Deutsche Gesellschaft für chemisches Apparatewesen, Frankfurt-am-Main W 13.

The annual **Research Equipment Exhibit and Instrument Symposium** is to be held 2-5 May at the National Institutes of Health, Bethesda, Md., under the sponsorship of the exhibiting manufacturers and the Washington sections of the American Chemical Society, the Instrument Society of America, the Society of American Bacteriologists, and the American Association of Clinical Chemists.

The topics to be discussed at the symposium sessions include electrophoresis and paper chromatography, fluorescence determination, optical methods in biochemistry, selection of electronic components for medical research, and instrumentation for cytochemical and microbiologic research.

The magnetics subcommittee of the basic science committee of the American Institute of Electrical Engineers, in cooperation with the American Physical Society and the American Institute of Mining and Metallurgical Engineers, has arranged a **conference and exhibit on magnetics** at the William Penn Hotel, Pittsburgh, Pa., 14-16 June.

The conference plans to hold six sessions devoted to magnetic materials, metallurgy of magnetic materials, mechanism of magnetization, application and manufacturing of soft materials, permanent magnets, measurements and techniques, ferrites, and high-frequency switching and storage of information.

The **American Anthropological Association** held its 53rd annual meeting in Detroit, 28-30 Dec. 1954, with the cosponsorship of the American Association of Physical Anthropologists, the American Ethnological Society, the Central States Anthropological Society, the Society for American Archaeology, and the Society for Applied Anthropology. Some 411 persons were registered.

Outstanding among the special sessions was the symposium on "Anthropology and Indian land claims litigation," a discussion of the problems that have arisen from the participation of anthropologists as "expert witnesses" in claims cases. Under the chairmanship of Verne F. Ray, seven speakers considered these subjects: the Indian Claims Commission Act and the difficulties of its application, particularly with regard to the definition of Indian groups; the development of the use of expert witnesses in Anglo-

Saxon legal history, with a discussion of the qualifications of such witnesses; research and the presentation of evidence; the problems, opportunities, and recommendations in connection with the role of the anthropologist in claims cases; the nature of the land-holding group, which suggested that in native North America the land-owning and sovereign political society was not what is usually called "the tribe," but smaller units; and finally, the challenges that the Indian litigation presents to the methodological and conceptual basis of anthropology.

Many excellent symposiums took place—one on stability and chance in patterns of prestige and leadership in Africa, one on the anthropological study of our own culture, one on archeological inference, and one on Eskimo acculturation. A special session on the problem of group character included a paper, "A new approach to the study of group character" by Alex Inkeles (sociologist, Russian Research Center, Harvard University) and Daniel J. Levinson (psychologist, department of social relations, Harvard). This stimulated a spirited discussion between John J. Honigsmann, Margaret Mead, Melford E. Spiro, Anthony F. C. Wallace, and John W. M. Whiting.

Two sessions on nativism, chaired by Homer G. Barnett and Omer S. Stewart, reflected the anthropologist's interest in social change and acculturation. Chairmen for two other sessions on acculturation were Milton L. Barnett and John Bennett.

In the session devoted to physical anthropology—James N. Spuhler, chairman—Sherwood L. Washburn suggested an improved method for classifying the spinal anatomy of men, apes, and monkeys. He said that if the spinal vertebrae of the three groups are counted in terms of function rather than in terms of apparent structure, the groups would fall into two distinct categories—apes and man, on the one hand, and monkeys on the other. Thus, the two lower-rib vertebrae in monkeys should be counted with the lumbar vertebrae because they serve an entirely different function in monkeys than they do in man and the apes.

Among the sessions devoted to archeology, the first, which dealt with American archeology, was chaired by Emil W. Haury, president of the association. The papers given by Irving Rouse and William C. Sturtevant on "Archaeological similarities between the Southeast and the West Indies," were important in that they reflected an awareness of the mutual assistance that archeology and ethnology can lend one another. The second of the archeological sessions consisted of a symposium on prehistoric cultural change in the Great Lakes area chaired by James B. Griffin. This symposium began with the reading by George Quimby of a paper by James Zumberge and J. E. Potzger entitled "Late Wisconsin chronology of the Lake Michigan Basin correlated with pollen profiles and radiocarbon dates." This article, which appeared on page 309 of the 25 Feb. issue of *Science* and which is a summary of a larger paper to appear in the *Journal of Geology*, provided information on the post-

Mankato history, particularly that of the southwestern Michigan area. In another archeological symposium, cosponsored by the Society for American Archaeology and chaired by Gordon R. Willey, the problem of archeological inference with reference to "settlements and society" was outlined in terms of major areas in the New World.

The biennial conference of the **Society for Research in Child Development**, held 31 Mar.-2 Apr., at Robert Allerton Park, conference center of the University of Illinois near Monticello, was attended by some 100 pediatricians, child psychologists, psychiatrists, nutritionists, and research dentists. Reports on research of the past 2 yr were given and projects for future study were discussed. William E. Martin of the College of Education was chairman of the conference.

Pathology in relation to environmental diseases is the theme of the scientific program of the dedication ceremonies of the new Armed Forces Institute of Pathology building, to be held 26-27 May at Walter Reed Army Medical Center. The institute is the central laboratory of pathology for the U.S. Army, Navy, Air Force, Veterans Administration, Public Health Service, Atomic Energy Commission, and other agencies. The program will be held in two sessions on 27 May at the Army Medical Center Theater, and will be presided over by Arnold R. Rich, professor of pathology, Johns Hopkins University Medical School, and Howard T. Karsner, research adviser to the Surgeon General, U.S. Navy. Papers will be read on ultraviolet cancer, malnutrition, acute renal failure, war wounds, and physiopathology of extreme changes in barometric pressure.

The 19th meeting of the **Mississippi Academy of Sciences** will be held at Meridian Municipal College in Meridian, Miss., on 29-30 Apr., with C. L. Deevers of Mississippi College presiding. The academy is sponsoring seven district science fairs this spring, and winners will compete at the State Science Fair held in conjunction with the meeting. The *State Times* of Jackson will donate cash prizes totaling \$775 to the fair, and scholarships of approximately \$2000 are expected from the five state-supported institutions of higher learning.

Education

A primary teaching affiliation between the **State University of New York College of Medicine** in Brooklyn and the Jewish Hospital of Brooklyn, the largest nonsectarian voluntary hospital in the Borough, has been announced. The affiliation, which provides for the teaching of medical students in the wards and in the outpatient services of the hospital's department of internal medicine, will serve to improve and broaden the teaching of internal medicine at the college.

As part of the agreement between the two institu-

tions, the director of the hospital's medical service will be appointed by joint action of the hospital trustees and the trustees of the university, upon nomination by the dean of the college. The director will hold a full professorship on the college faculty, and hospital staff members who assist in the instruction of students will receive academic appointments.

Recently dedicated at the University of Maryland was the \$8½ million **Glenn L. Martin Institute**. Comprising eight buildings, it houses the entire College of Engineering and many of the academic and research departments of the College of Arts and Sciences. The source of funds for the institute included an original gift of \$2.3 million by Glenn L. Martin, \$5,678,455.15 from the state of Maryland, and \$142,946.52 from the Office of Naval Research and Bureau of the Department of Defense Ordnance.

A new 15-story, 485-bed teaching hospital and the first unit of a new Medical Sciences Building on the San Francisco campus of the **University of California** were dedicated 18 Mar. The hospital was named for Herbert C. Moffitt, member of the Medical School faculty for 37 yr. It is integrated with the 14-story first unit of the Medical Sciences Building, and both clinical and research laboratories complement each other.

The hospital contains 10 surgeries, four of which are equipped with cables for originating closed-circuit television for teaching purposes. There is a rooming-in arrangement in the obstetrics ward. One floor, constructed with funds from the U.S. Public Health Service, is devoted entirely to cancer research. Another is occupied entirely by clinical laboratories.

The Medical Sciences Building houses the schools of medicine and nursing and the colleges of dentistry and pharmacy. A second unit of the building, with more extensive basic science laboratories, will be constructed after the demolition later this year of an old dental-pharmacy building.

Twenty-five students, carefully selected from the junior classes of major accredited engineering colleges on the basis of highest talent and promise in science and engineering, will participate in an **experiment in education** to be conducted next summer by Rensselaer Polytechnic Institute. The objective is to test an accelerated training program for the men at the top of their classes.

Not yet seniors, they will be given work on graduate levels to demonstrate whether students of their quality, without senior-year training, can successfully cope with graduate subjects. It is expected that the experiment will be watched with wide interest by educators, research organizations, and industry. The students will be taught by the regular R.P.I. faculty and by cooperating scientists from the Research Laboratory of the General Electric Co. at Schenectady.

So that all candidates can afford to participate in the project, every participant will be given a scholarship. Fifteen scholarships will provide tuition, living

expenses, and travel allowances, and 10 will provide tuition only.

The 6-wk program, which will be operated by the department of metallurgical engineering, will consist of two concurrent courses—one dealing with the modern physical chemistry of metals, the other with modern metal physics. Either of the courses will make the successful participant eligible to receive the same academic credits toward a degree that would normally result from a full semester course of about 17 wk.

The first grant to New Jersey's first medical school, **Seton Hall College of Medicine and Dentistry**, which will open in the fall of 1956, will be made by the International Academy of Proctology to establish a chair in proctology. The \$3000 grant will be used over a period of 3 yr, and the chair will be filled by visiting lecturers. The new medical and dental college of Seton Hall University, which has long conducted premedical and nursing programs, will be established in the Jersey City Medical Center.

The summer laboratory course in techniques and applications of the electron microscope will be given again this year at Cornell University by the laboratory of electron microscopy in the department of engineering physics. The course, which will take place 13-25 June under the direction of Benjamin M. Siegel, will have Cecil E. Hall of Massachusetts Institute of Technology and Robley C. Williams of the University of California, Berkeley, as guest lecturers.

The program is designed to provide an intensive survey of basic theory and interpretation of results, and registration is limited. Inquiries should be addressed to Prof. Benjamin M. Siegel, Department of Engineering Physics, Cornell University, Ithaca, N.Y.

On 26 May the **College of Medical Evangelists** will commemorate its 50th anniversary. Beginning modestly in 1905 with a small sanitarium, the college has developed schools of medicine, dentistry, and nursing, together with auxiliary areas of instruction in physical therapy, medical and x-ray technology, dietetics, and tropical and preventive medicine—now conducted at campuses in Loma Linda and Los Angeles, each with a medical center and other instructional facilities.

Recently the **University of Chicago** opened a \$60,000 clinic for the psychiatric treatment of emotionally disturbed children. The 15-room unit, located on the fourth floor of Bobs Roberts Memorial Hospital for Children in the University Medical Center, will be equipped to handle up to 100 patients per week when full operation is reached, probably by midsummer.

Announcement has been made of the establishment of the **Stanley Cobb Fund for the Development of Teaching and Research in Psychiatry** in the Harvard Medical School. Named for Stanley Cobb, who retired in June 1954 from the school with the title of Bullard professor of neuropathology emeritus, the main purpose of the new professorship is the integration of

psychiatric training with the other courses of instruction. It will also provide an opportunity for needed research in the field.

Until the required amount (\$500,000) is reached, the income from the fund may be used for the needs of the department of psychiatry or it may be accumulated. Gifts or bequests to the fund may be sent to the Treasurer of Harvard University, 140 Federal St., Boston, and designated for "The Stanley Cobb Fund."

The new 5-day course in principles of rehabilitation recently conducted by the Rehabilitation Center of the hospital of the **University of Pennsylvania** in cooperation with the Office of Vocational Rehabilitation, U.S. Department of Health, Education, and Welfare, will be repeated during the weeks beginning 18 Apr., 16 May, 13 June, and 18 July. There will be no tuition fee for physicians, dentists, registered nurses, occupational therapists, social workers, rehabilitation counselors, and others concerned with rehabilitation of the handicapped. Enrollment for each of the four sessions will be limited to 25 participants.

Rehabilitation principles and methods will be presented both through lectures and clinical demonstrations. In addition to the instructional staff of representatives from the various divisions of the University of Pennsylvania, there will be a number of guest lecturers. Provision for granting trainee stipends ranging from \$50 to \$100 to eligible persons attending the course has been made by the U.S. Office of Vocational Rehabilitation. Applications for these stipends, as well as for detailed information concerning the course, may be addressed to the Rehabilitation Center at the University Hospital, Philadelphia.

Available Fellowships and Awards

The National Multiple Sclerosis Society has established a limited number of fellowships to encourage promising students and scholars to conduct **research related to multiple sclerosis** and the demyelinating diseases. Successful candidates may choose their training institution and sponsor, making the necessary arrangements directly. However, they are urged to consider a training program that will lead to a career of research in this field.

There are two types of award. (i) Postdoctoral research fellowships will be given to qualified candidates who hold a doctorate in medicine or a related field. They afford a basic stipend of \$4000 to \$5000 per year, based upon the academic and professional training of the applicant and the faculty dependency status involved. (ii) Appointment as a scholar will be made to qualified candidates holding a doctorate in medicine or a related field who have demonstrated competence in biological investigation. This award will provide a stipend of \$6000 to \$8000 per year, based upon the academic record, professional training, and research attainments and interests of the applicant.

The awards are usually made for one calendar year, and may start any time within 8 mo of the date of notification of the award. One or two additional years of fellowship support may be requested; however, total tenure is not expected to exceed 3 yr. In all cases, extended support is dependent upon the terms of the original award and upon continued endorsement by the sponsor.

Fellows or scholars of the NMSS are permitted to spend a reasonable amount of their time in teaching. An annual allowance of \$150 is available for travel from home to the sponsoring institution or to medical meetings.

Upon application, grants of up to \$500 may be made to the sponsoring institution as reimbursement for costs incurred during the training program. Tuition and other usual, related fees are chargeable against this grant.

Awards will be announced twice yearly, in June and in December. Applications may be secured by writing to Harold Wainerdi, NMSS, 270 Park Ave., New York 17. They should be submitted to the NMSS together with supporting documents on or before 1 Sept. or 1 Mar. Except under unusual circumstances, awards will not be made or continued concurrent with other fellowships.

The Lederle Laboratories Division of the American Cyanamid Co. will make **Lederle Medical Student Research Fellowships** available to medical schools throughout the United States and Canada for the year 1955. These fellowships, in amounts not exceeding \$600 per year for any one individual, are intended to relieve in part the financial burden of students who desire to devote their summer vacations to research in the preclinical medical sciences.

Students who apply for the fellowships must be of good scholastic standing and must have the consent of the faculty member under whose supervision their research is to be conducted. The selection of those to receive the awards will be made by the dean of the medical school, or by the faculty committee charged with such selections. By special permission of the dean or the fellowship committee of the school, the student may carry on research in another medical school, provided that satisfactory arrangements are previously made with the faculty member of the school and the department in which the student is to carry on his research.

In 1956 the Royal Society of Edinburgh will award the **David Anderson-Berry silver-gilt medal**, together with approximately £100 to the person who, in the opinion of the council, has recently produced the best work on the therapeutical effect of x-rays on human diseases. Applications for this prize are invited. They may be based on both published and unpublished work, and should be accompanied by copies of relevant papers.

Applications must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George St., Edinburgh 2, Scotland, by 31 Mar. 1956.

In the Laboratories

The **Carter Oil Company's** new fluid coking unit, the first of its kind, was recently dedicated at Billings, Mont. Using a novel adaptation of the "fluid solids" technique of refining, the 196-ft coking unit will convert low-value residual oil into feed stock, which will be refined into gasolines and home-heating fuels. Besides increasing the gasoline output of the Carter plant by 74,000 gal/day, the process will also provide a new product, petroleum coke.

Establishment of the **Max Erb Instrument Co.** at 3333 W. Olympic Blvd., Los Angeles 19, has been announced. The company offers special service in problems of instrumentation and optical technique, and provides distribution for nationally known microscopes and other optical instruments. A consultant on microscopical equipment and technique for the University of California Scientific Laboratories at Los Alamos, Max Erb designed and manufactured the remote control metallograph in use at the GE Nuclear Laboratories at Hanford, Wash.

A new **forest genetics institute** has been established at Gulfport, Miss., by the U.S. Forest Service. Primary purpose of the institute will be to carry on basic research in tree breeding so that it can supply information to anyone trying to develop hybrids with some special characteristic such as fast growth, high pulp yield, or resistance to insects or diseases. The institute will build up a tree-breeding arboretum to provide specimens for the use of tree breeders. It will also serve as a southern information center on forest genetics by maintaining a file of all such projects in the South and elsewhere. Berch W. Henry is heading up work at the new institute. He is assisted by E. B. Snyder, geneticist, F. F. Jewell, pathologist, and L. F. Smith and R. M. Allen, silviculturists.

Plans for a new Electronics Division building have been revealed by **Westinghouse Electric Corporation**. The structure will be located on Fort Meade Rd. near Friendship Airport in Baltimore, and will comprise a total of 350,000 ft² of floor space. The new installation will provide an expanded and up-to-date development for the continued manufacture of electronic equipment for the Defense Department. Full operation is expected by January 1956.

In Waltham, Mass., the **Radio Corporation of America** has opened its new Aviation Systems Laboratory. Robert C. Seamans, Jr., will manage the new installation, which will be devoted to the development of an electronic fire-control system capable of detecting and destroying aircraft traveling at supersonic speeds. The laboratory will be equipped with elaborate computing facilities that will enable the engineers to simulate actual performance of airborne electronic systems under flight conditions. Modern jet aircraft will also be available for full-scale flight tests and studies.

A Is for Atom, a documentary film sponsored by the **General Electric Co.** and produced by John Sutherland Productions, has been awarded the second prize trophy, science film section of the documentary group, of the Venice Film Festival. The 15-min color film explains in simple terms the principles of nuclear fission, the structure of the 92 basic elements, and the process by which atomic energy is released. As a public service, GE films dealing with a wide range of subjects from farm modernization to jet propulsion are made available to schools, clubs, and other community groups without cost.

The new West Coast plant of **Fairchild Camera and Instrument Corp.** will be erected on a 6-acre site on E. Washington Blvd., less than 15 min from downtown Los Angeles. Present plans are for a building containing 24,000 ft² of floor space, with completion of the first unit expected in June. The plant is intended primarily to house the expanded manufacturing facilities of the Fairchild Potentiometer Division.

To integrate the activities of its expanding research program, **Mead Johnson and Co.** has created two new divisions. Rudolph C. Ellingson will direct the Division of Nutritional Research and Product Development; Marshall R. Warren will head the Division of Pharmaceutical Research and Development.

Expansion of its Bayonne, N.J., plant for manufacturing, processing, and formulating insecticides, was recently completed by **Stauffer Chemical Co.** of New York. The expansion program included the installation of additional units to increase the air milling capacity of the plant, as well as a modern unit for the formulation of liquid insecticides.

A completely equipped instrumentation laboratory has been outfitted in a 28-ft van trailer by engineers at **Armour Research Foundation** of Illinois Institute of Technology. Costing about \$25,000, the laboratory will be especially useful in projects where it is impractical to move equipment or material to a fixed laboratory. By means of a 4-channel cathode-ray oscillograph, it can measure and record pressure, stress, strain, thrust, torque, acceleration, velocity, temperature, and other mechanical phenomena. The mobile laboratory also contains a photographic darkroom, and can be fitted with other specialized electronic equipment that may be required for individual projects. Fully insulated, the trailer can be used in locations where commercial power is not available, since it has its own 5-kw gasoline-powered generator.

American Monomer Corp. and **Monomer-Polymer, Inc.**, chemical firms of Leominster, Mass., have been acquired by the Borden Co.'s Chemical Division. American Monomer is one of the country's largest producers of polyvinyl alcohol. It also manufactures a broad line of solid thermoplastic resins as well as specialty monomers and cross-linking agents. Monomer-Polymer is an organization engaged in research

on thermoplastic materials and also in manufacture of specialized monomers and polymers for research use. All personnel of the two firms will continue with Borden's including Sidney J. Baum, president of American Monomer, and Benjamin D. Halpern, president of Monomer-Polymer.

A research institute for the utilization of slag from smelters is in operation at the **Hüttenwerke Rheinhausen A.G.**, in Rheinhausen, Germany. In contrast to previous institutes of its kind, which specialized in the production of concrete from slag, the new institute is to extend its research to the whole field of slag and its exploitation for industrial uses.

Miscellaneous

Ten professional and 10 volunteer conservation workers have been announced as winners of the second annual \$5000 Nash Motors' conservation awards program. All will receive a bronze plaque and the professional conservationists will receive an additional award of \$500.

Winners in the professional class are: Robert P. Allen, Tavernier, Fla.; George William Bennett, Urbana, Ill.; Charles Wirth Bosch, Jr., New Orleans, La.; E. L. Cheatum, Albany, N.Y.; John S. Gottschalk, Washington, D.C.; Willard R. Hine, Atlanta, Ga.; Charles O. Handley, Sr., Charleston, W. Va.; Alexander J. Jaenicke, Portland, Ore.; William Thomas Ward, Kamloops, B.C.; Donald K. Wolff, Belvidere, N.J.

Winners in the nonprofessional class are: Thomas E. Doremus, Wilmington, Del.; Grover Austad, Salt Lake City, Utah; Clyde H. Getchell, Waterville, Me.; Harold Palmer Hastings, Claremont, N.H.; Max Krone, Idyllwild, Calif.; Carolyn Madden, Anaconda, Mont.; Robert Naylor, Emmett, Ida.; John R. Reddcliff, Warren, Pa.; O. B. Reemelin, Dayton, Ohio; Charles W. Stoddart, Jr., University Park, Pa.

Copies of *Transistors and Their Applications, a Bibliography, 1948-1953*, compiled under the direction of Alan R. Krull, which appeared originally in the *Transactions of the Institute of Radio Engineers' Professional Group on Electron Devices, August 1954*, are available gratis from the Technological Institute Library, Northwestern University, Evanston, Illinois.

Notice is hereby given that from 28 Aug. 1955 the **International Commission on Zoological Nomenclature** will start to vote on the following cases, involving the possible use of the plenary powers, for the purpose specified against each entry. Full particulars of these cases were published on 28 Feb. 1955, in Parts 3 and 4 of vol. 11 of the *Bulletin of Zoological Nomenclature*. (i) *Entomobrya* Rondani, 1861 (Cl. Insecta, Order Collembola), validation of; (ii) *Iphis* Leach, 1817 (Cl. Crustacea, Order Decapoda), validation of (correction of error in *Opinion* 73); (iii) *Homalaspis*

Milne Edwards (A.), 1863 (Cl. Crustacea, Order Decapoda), validation of (correction of error in *Opinion* 85); (iv) *Monticulipora* d'Orbigny, 1849 (Cl. Bryozoa), designation of type species for; (v) *obscura* Berezowsky & Bianchi, 1891 (*Larvicora*) (Cl. Aves), validation of; (vi) *bei* Ridgway, 1874 (*Eremophila alpestris* var.), suppression of; (vii) *dingo* Meyer, 1793 (*Canis*) (Cl. Mammalia), validation of, as the name for the Dingo; (viii) *Bombina* Oken, 1816 (Cl. Amphibia, Order Anura), conservation of; (ix) *Scolopendra* Linnaeus, 1758 (Cl. Myriapoda), designation of type species for.

The above parts also contain proposals for the adoption of two "Declarations": (i) clarifying Rule (g) of Article 30, relating to the selection of the type species, in cases where a species has two or more names objectively synonymous with one another; (ii) regarding the specific name to be adopted for the type species of a genus in cases where that species possesses two or more objectively synonymous such names. Comments on the above cases should be sent as soon as possible to Francis Hemming, Secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

Under contract with the U.S. Army's Office of Ordnance Research at Durham, Duke University will edit, assemble, and produce a series of 180 handbooks on current **engineering design data** on ordnance combat materiel, including jet-operated and rocket-launching devices, fire control, automotive assemblies, carriages, mounts, guns, ammunition, and other devices. The main project is scheduled to take approximately 5 yr, with periodic revisions required thereafter. Walker W. Holler, retired Army colonel who is now senior research associate in engineering at Duke, will direct the work.

A 32-page booklet entitled *The Peaceful Atom* is available for 60¢ a copy from American Museum of Atomic Energy, Oak Ridge, Tenn. The publication was compiled under the direction of A. Dixon Johnson, former head of the Information Department, Oak Ridge Institute of Nuclear Studies. It is profusely illustrated with photographs, diagrams, and sketches.

In March the **Museum of Science and Industry**, Chicago, opened a major addition to its medical section, an exhibit entitled "The Conquest of Pain" that tells the story of anesthesia. Sponsored by Abbott Laboratories, the exhibit was designed under the medical direction of the American Society of Anesthesiologists.

International Archives of Allergy and Applied Immunology, beginning with the issue of January 1955, will appear regularly on a monthly schedule. American authors should send their manuscripts for editorial consideration to the American editor-in-chief, Dr. William Kaufman, 540 Brooklawn Ave., Bridgeport, Conn.

Book Reviews

Lehrbuch der Paläobotanik. Walther Gothan and Hermann Weyland, Akademie-Verlag, Berlin, 1954. 535 pp. Illus. DM 46.

The book is a delayed revision of Potonié and Gothan's *Lehrbuch* of 1921. Subject matter is organized around the major plant groups which are arranged according to conventional schemes of classification. Four short introductory chapters deal with the history of paleobotany, kinds of plant fossils, fossilization processes, and pseudofossils. Some of the common research techniques are described. These chapters are followed by others on Algae, Algomyceetes, Fungi, and Bryophyta. Coverage of vascular plants begins with the Psilophytales, and proceeds through Filicales, Hydropteridales, Noeggerathiales, Articulatae, Lycopodiales, Gymnospermae, and Angiospermae. The concluding chapter discusses geologic, geographic, ecologic, and climatologic aspects of ancient floras.

The bulk of the manuscript was prepared several years before publication, and the numerous *Anhängen* reveal efforts to bring the subject matter up to date. North American literature of the last 25 years is very incompletely covered and selections are somewhat random. The same may be said of much of the postwar literature of western Europe. As inevitably happens in a book of comprehensive scope, one sees an occasional error of fact. For example some fossil fern stems belonging to three genera are stated (p. 171) to be growth stages of one genus and the statement is made (p. 174) that *Azolla* is known in the fossil state only from interglacial deposits.

With few exceptions the illustrations are ample. Most of the figures are taken from other sources and many are rather crude pen sketches of previously published photographs. The halftones are substandard. Some are too small and others are muddy, partly because of the inferior quality of the paper. Otherwise, the book is well printed, with few typographic errors. It is written in a readable style and can be understood by one fortified with only a moderate knowledge of German.

C. A. ARNOLD

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Organic Syntheses. vol. 34. William S. Johnson, Ed. Wiley, New York; Chapman & Hall, London, 1954. vi + 121 pp. Illus. \$3.50.

Volume 34, which maintains the general excellence and style of earlier volumes in this well-known series, contains checked laboratory directions for preparing the following compounds:

2-*p*-Acetylphenylhydroquinone, azelanitrile*, β -(*o*-carboxyphenyl)-propionic acid, cetylmalonic ester*, 2-chloro-1,1,2-trifluoroethyl ethyl ether, cycloheptanone (two methods), di-*tert*-butyl malonate*, 3,4-dihydro-2-methoxy-4-methyl-2H-pyran*, 9,10-dihydrophenanthrene, *p,p'*-dinitrobenzyl, 1,4-dinitrobu-

tane*, dimethylfurazan, diphenylacetylene*, diphenyl succinate, ethoxyacetylene*, ethyl chlorofluoroacetate, ethyl enanthylsuccinate*, ethyl β , β -pentamethylene-glycidate, hemimellitene, *o*-methylbenzyl alcohol*, 2-methylbenzyl dimethylamine*, N-methyl-1,2-diphenylethylamine and hydrochloride, methylisourea hydrochloride, 3-methyl-1,5-pentanediol, 3-methylthiophene*, phenanthrenequinone, 1-phenylpiperidine*, *o*-phthalaldehyde, sodium β -styrenesulfonate and β -styrenesulfonyl chloride, tetralin hydroperoxide, *p*-toluenesulfonyl chloride *p*-tolylsulfonylmethylnitrosamide, *o*-xylene dibromide.

The starred (*) compounds are prepared by directions stated to be applicable to one or (usually) more similar compounds. Cycloheptanone is prepared from cyclohexanone by two different ring-enlargement methods, one of which uses diazomethane prepared from *p*-tolylsulfonylmethylnitrosamide. Only the preparation of diphenylacetylene has appeared in earlier volumes, but the present preparation from benzil presumably affords a purer product than the earlier preparation from stilbene. Workers in phenanthrene chemistry will be pleased with the preparation of phenanthrenequinone from technical (or recrystallized practical) phenanthrene and with the description of the special purification of phenanthrene which is so essential for its successful reduction to dihydrophenanthrene.

The extent to which *Organic Syntheses* expedites laboratory work cannot be measured. Volume 34, like its predecessors, will be in every organic laboratory.

I. MOYER HUNSBERGER

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Chemical Pathways of Metabolism. vol. II. David M. Greenberg, Ed. Academic Press, New York, 1954. viii + 383 pp. Illus. \$9.50.

Whereas the first volume of *Chemical Pathways of Metabolism* dealt essentially with C, H, O compounds, the second volume concerns primarily the stepwise origin and fate of nitrogen compounds in the animal body or more often in isolated enzyme systems. Volume II has eight chapters (9-16), and more than half the pages are devoted to the amino acids and derivatives. The review draws heavily upon results obtained with isotope tags within the last 10 or 15 years and bears witness to the greatly increased use of microbiological preparations in the study of biochemical mechanisms.

In the opening chapters, "Nitrogen metabolism of amino acids," by P. P. Cohen, "Carbon catabolism of amino acids" and "Synthetic processes involving amino acids," both by D. M. Greenberg, the presentation proceeds logically from the metabolism of the common $-\text{NH}_2$ group, to the degradation of the unique carbon skeletons of amino acids, and finally to special features of the biosynthesis of amino acids and

related metabolites. In the next chapter, "Metabolism of sulfur-containing compounds," Greenberg gives further information on methionine and cysteine and describes the important role of the sulfur group in several coenzymes. H. Borsook, author of "Enzymatic syntheses of peptide bonds," presents the biochemical data in terms of thermodynamic types. Such welding of organic and physical chemistry treatment is most desirable. The important nuclear substances are covered in the next two chapters, "Purines and pyrimidines," by M. P. Schulman, and "Nucleotides and nucleosides," by L. A. Heppel. The first of these deals with the modes of synthesis and breakdown; the second, with deamination as well as enzymatic splitting and exchange, with special reference to synthesis of the coenzyme nucleotides. In the last chapter, "Metabolism of heme and chlorophyll," S. Granick traces the metabolic pathways of principal members of the porphyrin family, giving more space to the heme than the chlorophyll branch.

The book is authoritatively written and is interlarded with hundreds of citations of original articles. The chapter organization follows a uniform pattern. The authors are to be commended for the clarity achieved through liberal use of graphic formulas and diagrams in presenting complicated structure and mechanism. Although the story at times becomes involved, I found little that could be pruned. The volume is printed on good paper, is relatively free of error, and is well indexed by both author and subject. It is recommended to all those interested in a comprehensive review of this field.

RICHARD W. JACKSON
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An Outline of Developmental Physiology. Chr. P. Raven. Trans. by L. de Ruiter. McGraw-Hill, New York; Pergamon Press, London, 1st Eng. ed., 1954. viii + 216 pp. Illus. + plates. \$5.50.

This book was written to introduce topics of interest in embryology. The fault in accepting this as the total tale is in the reader, not the author.

This work was completed in 1942, published in Dutch in 1948, with an English translation in 1954. In it Raven has given a running account that brings together the parts of the developmental story which never should have been separated. The separatists usually subdivide the continuity of embryology by stressing the individual attacks upon the continuum of development. Embryology is, therefore, referred to as consisting of (i) classical (prehistoric or maybe slightly in the historic period), (ii) experimental, which is premodern, (iii) chemical, including enzymatic, almost modern, and (iv) novogenesis. In this artificially fragmented area both the embryo and the embryologists are bewildered.

Raven has attempted to discard some of these artificialities in giving a nicely organized view of the embryo from the standpoint of the embryo's chronology.

He has oversimplified the treatment of his topics with full knowledge and intent, for he is trying to present a subject to readers who are new to it. He has avoided as far as possible the overcomplicated jargon which has been superimposed upon the description of development. Since such treatment must always be a compromise, many experts will take exception to all of the book and all will object to some of it. This is a calculated risk that Raven must have had in mind. As for the embryo, it will be a relief to try to develop in Raven's pattern rather than some of the others which it finds entirely too difficult to follow.

JOHN S. NICHOLAS
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Elements of Food Engineering. vol. 3: *Unit Operations*, pt. 2. Milton E. Parker. With the collaboration of Ellery H. Harvey and E. S. Staleler. Reinhold, New York, 1954. 241 pp. Illus. \$6.75.

In this third volume of *Elements of Food Engineering* the authors complete their discussion on the conversion of raw materials, the first part of which was presented in volume 2. In this continuation, special reference is given to aspects of evaporating and distilling, dehydration and drying, and controlling as a unit operation.

In the chapter on evaporating and distilling, there are descriptions of atmospheric evaporators including steam-jacketed kettles and pans, jam pans, continuous sugar cookers, an atmospheric concentrator, reduced-pressure evaporators (including single-effect, multiple-effect, and recompression evaporators), and distillation equipment.

The procedures used and the types of equipment available for food dehydration or drying of solid and liquid foods are presented. An explanation is given of the general practice of quality control by objective testing and statistical analysis, and there is a section on measurements of temperature, pressure, humidity, fluid flow, and liquid level as well as a brief discussion of the instruments that may be utilized in controlling the physical properties and the composition variables of processed food products, ingredients, and raw materials.

A chapter on the treatment of the final products of food processing is concerned with the unit operations of coating, decorating, panning, enrobing, forming, and packaging.

Considerable space is devoted to the packaging aspects of food engineering, including descriptions and various tests of the properties of packaging materials, the different forms of packaging containers, packaging machinery, and the different aspects of quality control in food packaging, such as the legal, purchasing, production, traffic, sales, consumer, and sampling aspects.

Definitions and explanations of technical terms used, illustrations and diagrams of equipment, tabular presentation of information, formulas, and equations for

calculations are liberally interspersed throughout this 240-page book. A seven-page subject index helps the reader to locate topics of special interest.

B. E. PROCTOR

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New Instrumental Methods in Electrochemistry.

Theory, instrumentation, and applications to analytical and physical chemistry. Paul Delahay. Interscience, New York-London, 1954. 454 pp. Illus. \$11.50.

Everyone who has followed the rapidly increasing interest in the development of electrochemical methods, which are of interest to both analytical and physical chemists, will welcome this textbook written by one who himself has contributed extensively to these new developments. The theoretical fundamentals and critical examination of the new methods are presented in sufficient detail, along with some data from typical experiments. In the mathematical derivations, after the problem is set up and the assumptions are clearly presented, the details are omitted. However, the solution of each diffusion problem is discussed fully.

Part I begins with a chapter that reviews the newer electrochemical methods. This is followed by 9 chapters that discuss subjects such as electrode potentials and the kinetics of electrochemical reactions, also voltammetry and polarography at constant potentials for reversible, irreversible, kinetic, and catalytic processes. Here is presented the work that has been done in the field of irreversible waves and kinetic currents by such pioneers as Brdicka, Wiesner, Koutecky, and not least by the author himself. Throughout the entire book numerous references are given to the original literature. There are chapters dealing with polarography using continuously or periodically changing potential, or voltammetry at controlled current in stirred solutions or with moving electrodes. There is even a chapter on the use of polarized electrodes in potentiometric titrations. More than half of the text is devoted to Part I.

Coulometry and electrolytic separations are presented in Part II. Here one can find, for example, a description of recently introduced methods of coulometry at controlled potentials or coulometric titrations, or even methods for determining the thickness of metallic coatings and corrosion films.

The chapter in Part III on the use of high-frequency circuits, written by Charles N. Reilley, presents a well-written mathematical analysis of both the condenser and coil types of circuits, together with applications and instrumentation. The discussion outlines the possibilities of this new analytic tool not yet fully explored in the laboratory.

In Part IV descriptions are found of the instruments and circuits that are required and have been designed for these newer techniques. Here are diagrams of various types of electrodes for electrolysis,

circuits for electric integration or differentiation, or various kinds of coulometers.

In the appendix there is a brief presentation of the Laplace transformation, which the author uses extensively for the solution of the partial differential equations that are developed at numerous places in the text. This indicates the thoroughness with which the author has presented his subject.

THOS. DE VRIES

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Water Supply and Waste-Water Disposal. Gordon Maskeu Fair and John Charles Geyer. With a chapter (on water chemistry) by John Carrell Morris. Wiley, New York; Chapman & Hall, London, 1954. xii + 973 pp. Illus. \$15.

The first half of this work deals with the collection and distribution of water and the collection and removal of waste water. The second half deals with the treatment of water and waste water. Among the topics presented with accompanying examples are analysis of hydrologic data, collection of surface and ground water, water supply and drainage of buildings, flow in sewers and their appurtenances, biology of water and waste water, and industrial water supply and wastewater disposal.

This book sets forth many of the important advances that reduce water sanitation to an orderly process of calculation. In order to emphasize fundamentals, the authors have classified the subject matter according to principles. "Principles rather than practice, methodology rather than method, and rationality rather than rule of thumb" are stressed. To give emphasis to principles, a structural rather than a functional treatment of subject matter has been chosen. "This has made for an integrated discussion of water supply and waste-water disposal." Such a presentation in my experience and in that of some other teachers in the field has not been found successful below the second year of postgraduate study.

This is not a handbook on engineering practice (descriptions of materials, methods, equipment, and structures have been kept to a necessary minimum). It is intended however as a reference for practicing engineers. An appendix includes useful tables and a diagram that facilitates the solution of the Williams-Hazen formula for the flow of water in pipes.

Especially commendable features are the chapter, "Statistical analysis of quantitative information"; the chapters, "Ground water" and "Collection of ground water," which include much-needed discussions of the hydrologic and hydraulic aspects of the problem of evaluating ground-water resources; the chapter, "Physical properties of water"; the treatment of acid-base equilibria and oxidation potentials in the chapter, "Elements of water chemistry"; and the extensive coverage of the literature.

It is unfortunate that the two chapters on ground water are separated by the chapter, "Surface water collection." The omission of reference to Dorsey's

monograph in the bibliography on physical properties is hardly excusable. Unfortunately, references are not assembled but are found distributed through footnotes, a topical list of reference works, and a supplementary list arranged by chapters. In spite of these and other shortcomings, the book contains a worthy amount of useful material. We have purchased a copy for our staff, in addition to the one furnished for review.

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Technical Papers

Chemical Identification of the Amanita Toxin in Mushrooms

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Folklore has provided many fanciful but dangerous procedures for distinguishing poisonous from nonpoisonous mushrooms: "A poisonous mushroom has a peculiar color or odor." "It will turn a silver coin black." "It has a devil's cup." Although these fallacious concepts have general popular acceptance, the mycologist depends upon complete botanical identification. This, however, is sometimes difficult or impossible. For example, there is the case in which a child has eaten a wild mushroom, and the worried mother can produce no specimen or perhaps only a small fragment of the mushroom.

It is reported (1) that fully 90 percent of the deaths caused by poisonous mushrooms—about 50 each year in the United States (2)—result from the closely related *Amanita phalloides*, *A. verna*, and *A. virosa*. These mushrooms contain the amanita toxin, which does not induce its toxic manifestations for 10 to 15 hr after ingestion, thus permitting thorough absorption of the toxin (3). This toxin does not have an available antidote (4) although the symptoms are relieved with injections of glucose and amino acids (5). This toxin is therefore unlike muscarine, from *A. muscaria*, which produces symptoms quickly and is specifically antidoted by atropine (3). Thanks to the works of Kobert, Ford, and the Wielands, with their associates, we know that the toxin of *A. phalloides* is made up of four components: a hemolytic glucoside, phallin; and three peptides, phalloidine, α -amanitine, and β -amanitine, which affect the liver, kidney, and heart. Since the amanitines are not destroyed when the mushrooms are cooked, these toxins are of primary importance in cases of poisoning. They represent 0.005 percent of the fresh *A. phalloides* (6) and have a minimum lethal dose of 0.1 to 0.4 mg/kg to dogs (7) and mice (8). Human beings and guinea pigs are even more susceptible (9).

A simple rapid method for chemically identifying the amanita toxins in mushrooms has been developed and tested in our laboratories. It will permit the identification of the toxin in as little as 0.1 g of fresh mushroom tissue. This method can be run by any technician and takes 1 hour, provided that the reagents and equipment are at hand. It is based upon a sensitive color test giving a violet color with the amanitines and a bright blue color with phalloidine (6). A survey of more than 50 mushrooms, representing 46 species (including 13 amanitas, but not *A. muscaria*) was made employing this procedure. Each mushroom extract was also tested for toxicity to mice by intra-

venous injection. Only the mushrooms that gave a positive color test for the amanitines [*A. verna* (the Destroying Angel) and *A. tenuifolia* (10)] were lethal to the mice. All the other fungi, except one, gave negative tests and were nontoxic. The exception, *Lepiota cretacea*, gave a weak violet color but no toxicity. Since the specimen employed was very small, it remains to be determined whether, in this exceptional case, there was an interfering substance or whether a small quantity of amanitine was actually present.

The procedure is as follows. The mushroom is minced but preferably not mashed and covered with several volumes of methanol in a beaker. Extract the tissue by heating the mixture to boiling and keeping it hot for 2 min or longer; during the heating stir the mixture and press the tissue with a stirring rod. (Do not inhale vapors of methanol.) Separate the extracted tissue by filtration or centrifuging, pressing it to squeeze out the liquid. The tissue is discarded, and the methanol extract is evaporated to dryness on a steam bath. If only a small quantity of tissue is available for extraction, the container in which the extract is evaporated should be correspondingly small. A centrifuge tube is desirable so that the residue after evaporation will be concentrated at one point.

This residue may then be dissolved in a few drops or more of methanol, depending upon the quantity of tissue employed. The more concentrated the solution, the better. The residue that does not dissolve in methanol may be compacted and separated from the liquid by centrifuging.

The concentrated methanol solution is then used to run a chromatogram. A strip of filter paper (Whatman No. 1 or S & S 2043b), measuring 1 by 10 in., is marked with a pencil dot centered 1 in. from the bottom of the paper. With a glass capillary tube, apply the solution to the filter paper directly on the dot. After each application, permit the methanol to evaporate and repeat the process several times so that the applied material will be concentrated in a circle around the dot not larger than 1/16 in. in diameter. The filter paper is immersed up to 0.5 in. from the dot in a chromatographic solvent made up of 20:6:5:1 parts methyl ethyl ketone, acetone, water, and butanol, respectively. The paper strip, immersed in the solvent, is suspended free of the sides of the tube or cylinder container, which is then stoppered.

After 40 min the strip is removed and hung by the top to dry. It is then sprayed lightly with a solution of 1-percent cinnamaldehyde in methanol, allowed to dry, and suspended in a stoppered tube above concentrated hydrochloric acid. As soon as the color develops, the strip may be removed and examined. The appearance of one or more violet- or blue-colored spots on the paper indicates the presence of the amanita toxin. Orange, yellow, brown, or pink spots are not significant.

If this procedure is to be used for research rather than for simple detection of the toxin, the following three modifications are recommended. Extract the mushroom tissue in methanol for 1 hr or longer. Evaporate the methanol extract and redissolve the residue three times to coagulate the polypeptides. Employ a 14-in. filter-paper strip and run the chromatogram for 2 hr. These modifications assist in the extraction and separation of the individual toxins.

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20 December 1954.

Effect of Hypothermia on 17-Hydroxycorticosteroid Secretion in Adrenal Venous Blood in the Dog

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This paper summarizes our studies on adrenal vein 17-hydroxycorticosteroid secretion in acutely traumatized dogs during the induction of and rewarming from hypothermia. Adrenal venous blood samples were obtained by a technique (1) that consists of placing a cannula in the lumbar portion of the lumbo-adrenal vein, and intermittently occluding the adrenal vein-caval junction by means of a polyethylene choker for periods of 1 min. 17-Hydroxycorticosteroids were determined by the method of Nelson and Samuels (2). Hypothermia was induced in 20 mongrel male dogs either by cooling an external vascular shunt or

Table 1. Experiments in which hypothermia was carried to 25 percent or less of normothermic 17-hydroxycorticosteroid minute output in adrenal venous blood.

No. of dogs	Temperature (°C) at which 25% of normothermic corticoid output was reached
6	27.0-28.0
5	26.0-26.9
4	25.0-25.9
1	23.0
1	22.0

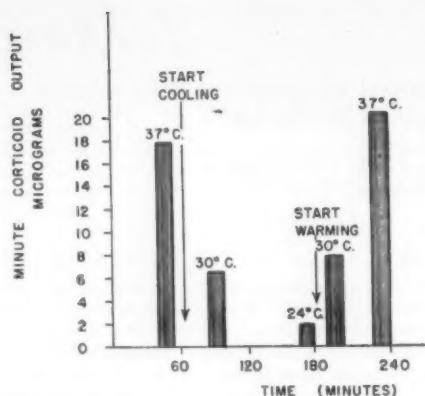


Fig. 1. Typical hypothermia experiment.

by ice water immersion. In three of these experiments the animals were given a continuous intravenous infusion of ACTH, 40 U/1000 ml of 0.99-percent NaCl at a rate of 40 drops/min.

Table 1 illustrates that in most animals hypothermia to between 25° and 28°C is accompanied by a 75-percent decrease in adrenal venous blood minute corticoid output, but that an occasional animal may be cooled to lower temperatures before such a decrease is observed. Figure 1 is an example of a typical experiment demonstrating a marked fall in minute corticoid output from the adrenal gland during hypothermia, near-zero corticoid values at 24°C, and return to normal values upon rewarming. In Fig. 2, a similar sequence of events, with near-zero corticoid values at 21°C, is shown in an animal receiving an ACTH infusion during the procedure. In general, adrenal venous blood flow decreased with progressive hypothermia, as did the minute corticoid output. There were occasional exceptions, however, in which a relatively high adrenal blood flow was associated with a low minute corticoid output. Maintenance of the normal systemic blood pressure by the infusion of norepinephrine did not alter the minute corticoid output

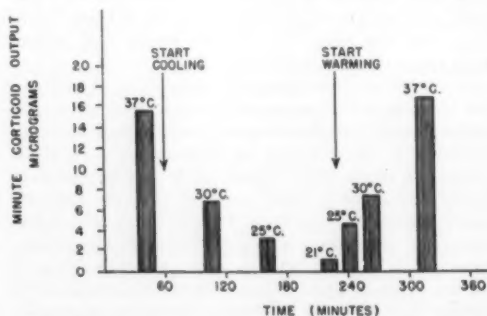


Fig. 2. Hypothermia experiment during which the animal received ACTH infusion.

decrease in hypothermia. That the decreased corticoid output in hypothermia was not due to a decreased release of pituitary ACTH was shown by the consistent corticoid fall despite the administration of an ACTH infusion. Diminished adrenal corticoid secretion in hypothermic dogs appears to be caused by direct adrenal suppression by cold, as shown by the decrease in minute corticoid output observed when local cold was applied to the adrenal gland and systemic normothermia was maintained. Cold exposure of the intact, normothermic dog at -10°C for periods up to 34 hr, in contrast to hypothermia, does not alter the normal adrenal response to ACTH.

Adrenal cortical secretion in response to exogenously administered ACTH or to the endogenous ACTH release that accompanies surgical trauma is markedly reduced in the hypothermic animal.

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7 February 1955.

Absorption of Antibiotics by Plant Cells

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Present information indicates that animal cells are impermeable to streptomycin (1), but are permeable to penicillin (2). Penicillin has been shown to be bound and concentrated by bacteria (3), but not by yeast (4). Although the ability of antibiotics to penetrate plant cells other than microorganisms has been frequently discussed (5), it has not been subjected to direct investigation. In this paper (6), preliminary observations on the absorption of chloramphenicol, penicillin, and streptomycin by cells of the alga *Nitella clavata* (7) are described.

Growth of the fresh water characean *Nitella* is differentiated into nodes and internodes with whorled laterals arising at the nodes. The elongate internodes are single cells. These plant cells are ideal for permeability studies since they are large enough for the sap of an individual cell to be removed and analyzed. The cells studied are cylindrical, 0.5 to 1.0 mm in diameter and up to 10 cm in length. They are multinucleate and contain a large central vacuole surrounded by a delicate layer of protoplasm. The protoplasm is in a constant state of cyclosis.

Each of the three antibiotics that were investigated represents a different ionic species. Chloramphenicol is a neutral compound. Penicillin ($\text{pK}_a = 2.7$) is acidic (8) and more than 95-percent ionized in the physiologically important pH range of 4 to 8. Three basic groups are present in the streptomycin molecule. During titration only the weakly basic methylamino group

is in evidence ($\text{pK}_a = 7.7$). The two guanido groups remain completely ionized (9).

Experiments were performed with freshly cut cells under fluorescent light in a constant-temperature room at 28°C . Antibiotic solutions were prepared with M/45 phosphate buffer. An appropriate number of cells contained in a large Petri dish (15 cm) were simultaneously suspended in a shallow layer of antibiotic solution. At various times after treatment, cells were withdrawn, washed by rapid immersion in four changes of distilled water, and placed in a buffer. The washed cells were dried against filter paper. When one end of a cell was cut off and pressure applied to the other, a droplet of sap flowed out. Sufficient sap (0.01 ml) was collected with a calibrated micropipette to uniformly wet a paper disk (7 mm in diameter). The sap of two to four cells was required to provide the necessary 0.01 ml. The concentration of the antibiotic in cell sap was determined by bioassay, using *Bacillus subtilis* as the test organism and nutrient agar as the assay medium. Standards were prepared by applying 0.01 ml of solutions of known antibiotic concentration to paper disks. The assay procedure has a lower limit of approximately 20 to 25 $\mu\text{g}/\text{ml}$ for chloramphenicol and streptomycin and of 8 $\mu\text{g}/\text{ml}$ for penicillin. All determinations were replicated at least three times. The assay measures the concentration of active antibiotic in cellular fluid. It will not detect any antibiotic that has been absorbed and inactivated. The absorption of streptomycin, chloramphenicol, and penicillin by living cells of *N. clavata* is shown in Fig. 1.

Streptomycin was rapidly absorbed and accumulated by the cells. The concentration of antibiotic in cells after 12 min of treatment was equal to that in solution. After 18.5 hr, the cells had accumulated streptomycin to more than 7 times the concentration in solution. The accumulation of streptomycin was

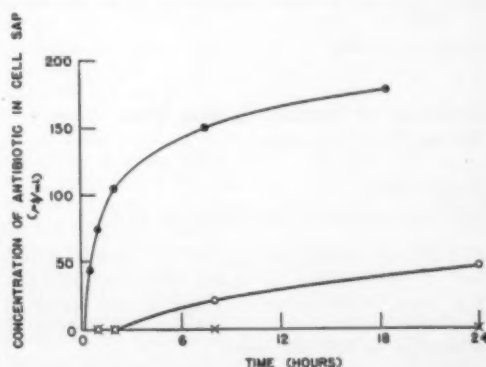


Fig. 1. The absorption of antibiotics by cells of *N. clavata*. Cells were suspended in the following antibiotic solutions prepared with M/45 phosphate buffer of pH 6.1: ●, 25 $\mu\text{g}/\text{ml}$ of streptomycin sulfate; ○, 136 $\mu\text{g}/\text{ml}$ of chloramphenicol; and ×, 128 $\mu\text{g}/\text{ml}$ of potassium penicillin G.

influenced by temperature ($Q_{10}=2.0$), pH (optimum pH=5.0), and the respiratory inhibitors NaN_3 and 2,4-dinitrophenyl; *o*-phenanthroline and NaAsO_2 had no effect. These results suggest an active transport of the basic streptomycin ion across the cell membrane.

Chloramphenicol was not detected in cells treated for 2 hr, but was present after 8 hr. Following 24 hr of treatment, the concentration of antibiotic in cells was less than one-half that in solution. The relatively slow absorption of chloramphenicol appears to depend on simple diffusion.

No antibiotic activity was demonstrated in cells treated with penicillin for 25 hr. This may indicate that if the penicillin ion is able to penetrate the cells at all, it does so at a greatly reduced rate in relation to streptomycin and chloramphenicol. Alternatively, penicillin may be absorbed but inactivated by the cells and, therefore, not detected by the bio-assay procedure. This possibility is being investigated. Detailed studies on the absorption of chloramphenicol, penicillin, and streptomycin are being continued and will be published elsewhere.

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12 December 1954.

Isolation of Organic Carbon from Bones for C^{14} Dating

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A method recently used in the U.S. Geological Survey (1) for isolating the carbon from two fossil animal bones to determine their age by the carbon-14 technique (2, 3) may be of interest to investigators attempting to date old bones.

The bone samples, partly coated with clay, came from a sandstone deposit in Craven Canyon, South Dakota. Because secondary carbonates were present as white incrustations and impregnations of exposed porous bone structure, the carbon for age determinations had to be restricted to organic carbon. Neverthe-

Table 1. Sample weights and carbon yield (g).

Samples as received	Clean samples	Char	Carbon recovered
290	196	161	1.8
190	146	119	3.8

less, the possibility of the presence of secondary organic matter should be taken into account.

Because relatively small samples were available (196 and 146 g of clean bone), it was decided not to attempt the isolation of organic matter by selective solution of mineral matter; poor separations resulting in a low yield of organic matter would have yielded insufficient carbon for age determinations.

The method used consisted of pyrolysis of the bone in a nitrogen atmosphere, followed by acid solution of the mineral matter. The residual carbon was collected by centrifuging. The sample weights and carbon yield are shown in Table 1.

Material that was obviously extraneous (mostly clay) was removed mechanically from the bones. The cleaned bones were then broken into small pieces of about 4-mesh size. Charges of 40 to 50 g were placed in the central part of a 3-ft length of quartz tube 1 in. in diameter. The tube was heated by a 1-ft hinged-type combustion furnace that was controlled by an autotransformer. Nitrogen from a gas cylinder was passed over heated copper to remove oxygen and then through the quartz tube. The effluent gas was piped into a hood to remove malodorous vapors formed during the pyrolysis.

The quartz tube containing the sample charge was flushed with nitrogen for 10 to 15 min, and then the furnace was heated at a low-voltage setting (maximum temperature 340°C) for 60 min. The voltage was then increased and the sample was heated for an additional 90 min (maximum temperature 650°C). The bones were converted to a black char at the high temperature. A small amount of liquid condensed in the cool portion of the tube, but no attempt was made to collect the liquid. After completion of the charring, the tube was taken from the furnace and cooled to room temperature without interrupting the flow of nitrogen.

The total char from each sample was then treated in a beaker with 6N hydrochloric acid. After the initial effervescence subsided, the samples were digested on a steam bath for several hours. They yielded a residue consisting largely of quartz and carbon. The suspended carbon was separated from most of the quartz by decantation. The carbon and remaining insoluble matter were then separated from the solution by centrifuging. The residue was washed three times with 3N hydrochloric acid, and the insoluble matter was separated after each washing by centrifuging.

The remaining mineral matter was dissolved by transferring the residue to a platinum dish and digesting it overnight with hydrofluoric acid on a steam

bath. The hydrofluoric acid was evaporated; the residue was digested and then washed five times with 3*N* hydrochloric acid. After each washing the carbon was separated by centrifuging and was finally dried in an oven at 105°C.

The digestion with hydrofluoric acid is probably not essential, but it does result in a cleaner specimen of carbon and was done with these samples to determine the yield of carbon.

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28 January 1955.

Rearing of Honeybee Larvae on Royal Jelly in the Laboratory

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For the first 3 days of life, the female larva of the honeybee (*Apis mellifera* L.) has the potential of developing into a queen or a worker, the direction of differentiation depending on the food that the larva receives. Queen larvae are mass fed a superabundance of royal jelly, which is secreted, at least in part, by the pharyngeal glands of adult bees. Worker larvae are also given a glandular food for about the first 3 days of life; thereafter they are progressively fed on small amounts of a food that normally contains pollen.

Rhein (1) collected royal jelly from queen cells and fed it to larvae in the laboratory. Only workers were produced. The experiment has been repeated by others (2) with the same results. It has been commonly assumed that the nurse bees give some substance directly to queen larvae rather than including it in the royal jelly, but since alternate explanations are possible, it seemed worthwhile to investigate the matter further (3).

In the first series of experiments, queen larvae, about 36 hr old, were removed from their cells and replaced by larvae of about the same age from worker cells. A screen lined with dampened cotton excluded adults from further contact with the larvae. Every 2 hr the larvae were transferred to fresh queen cells. Two adults were produced by this technique. Larvae were also reared in glass queen cells in a constant-temperature cabinet held at $34^{\circ} \pm 1^{\circ}\text{C}$ and a relative humidity of more than 75 percent. Every 2 hr royal jelly was pipetted directly from queen cells into the glass cells containing larvae of about the same age. Two adults were produced. The adults that were reared by these techniques were not workerlike in any characteristic observed, and they were queenlike in appearance, abdomen size, form of metathoracic legs

and mandibles, number of barbs on the sting, tongue length, and size of mandibular glands, spermatheca, and ovaries. The number of ovarioles fell at the lower range of variation for normal queens, varying from 102 to 161 (mean 124) ovarioles per ovary, as compared with 115 to 238 (mean 169) in a typical group of normal queens. Of three pupae in which some differentiation was evident before death, one appeared to be queenlike in the few characteristics that could be observed; the others were intermediate in tongue length, and in the size of the abdomen and spermatheca, and they had workerlike metathoracic legs.

Royal jelly that had been removed from queen cells daily and had been refrigerated at about 5°C for 1 to 4 wk was fed every 2 hr to larvae in glass cells in the constant-temperature cabinet. The one adult obtained was intermediate between queen and worker. The metathoracic legs were workerlike in form; the sting was queenlike; the abdomen, mandibular glands, ovaries, and spermatheca were intermediate in size, the mandibles were intermediate in form, and there were 66 ovarioles in the ovary in which a count was possible. One pupa was also produced by this treatment. It was intermediate in tongue length and in the size of the abdomen and ovaries, and workerlike in all other characteristics that could be observed.

In an attempt to develop an easier, more efficient feeding technique, five larvae were placed in royal jelly in a Petri dish containing a ball of dampened cotton. The larvae were transferred to a different dish of royal jelly daily. Only one adult was reared on royal jelly that had been collected daily and stored in the refrigerator under carbon dioxide for about 2 wk. The metathoracic legs, mandibles, and sting were workerlike; the weight, size of the abdomen and mandibular glands, and tongue length were intermediate; the ovaries and spermatheca were queenlike; there were 135 ovarioles per ovary. Another adult was produced on the same royal jelly from which the aforementioned larvae had been removed. The jelly was slightly desiccated and had been held at 34°C for 24 hr when the larvae were placed in it. This individual was workerlike in every respect; there were four ovarioles per ovary.

Nineteen adults were produced by the same technique from royal jelly that had been stored at 5°C for about a year. Some of the jelly was left in an open container in the laboratory to allow desiccation to the consistency of a heavy paste; some was diluted 10 and 20 percent with distilled water; and some was left unaltered. All the adults, except those reared on the drier royal jelly, had larger abdomens and were heavier than normal workers. This greater size and weight appeared to have been caused by extensive fat bodies in the abdomens. The ovaries of several individuals were not found, but it is not certain that they were absent since, in the laboratory-reared queens and in the intermediates produced by other techniques, the ovaries sometimes had about the same consistency as fat bodies. All 27 of the ovaries found were well within the range of normal workers and had a mean

of 4.4 ovarioles per ovary. Three individuals had spermatheca much larger than those of normal workers, but all other characteristics of these bees were workerlike.

In the studies of dimorphism in the honeybee that have been conducted in this laboratory, high mortality has always occurred in the treatments from which intermediates between queens and workers were produced. Furthermore, most individuals have been predominately queenlike or predominately workerlike, and those structures that have been intermediate in form or size have usually been rather near the range of variation of either queens or workers. These facts make it difficult to assess the potential of any treatment from a study of the resulting adults.

It has been proposed (4) that partial starvation of worker larvae could be an initiating mechanism in dimorphism. Since these laboratory-reared larvae had all the food they could ingest at all times, quantitative starvation could not be the determining mechanism. It is evident that there is a substance or substances in royal jelly that initiates or controls differentiation of queens, and that at least some essential part of it is either highly labile or is not available to larvae after the jelly has been stored for a time. Until methods are developed for preserving the biological activity of royal jelly for honeybee larvae, studies of the effect of royal jelly on other animals (5) may yield misleading results.

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3 January 1955.

Use of Plants as Biological Indicators of Smog in the Air of Los Angeles County

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Intensive investigation of crop damage by smog in the Los Angeles area began in 1947 (1, 2). At present, smog is understood to be a complex of liquids, solids, and gases, comprising more than 50 chemical elements and compounds and producing, among other effects, low visibility, eye, nose and throat irritation, crop damage, excessive rubber cracking and odor nuisances. Certain species of vegetables, ornamentals, and weeds were shown to be singularly sensitive (3). Damage symptoms differ from those ascribed to any previously studied gases, including SO_2 (4), hydrogen

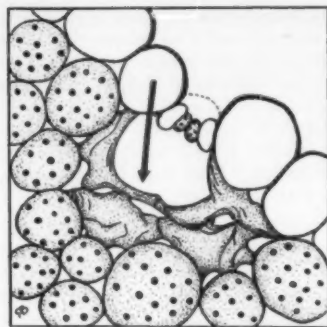


Fig. 1. Smog damage in *Poa annua* leaf, showing dehydrated cells (arrow) directly beneath stomata and surrounding substomatal chamber.

fluoride (5), and illuminating gas and smoke from industrial stacks (6). Field damage is considered to be due to certain intermediate products resulting from the chemical combination of unsaturated hydrocarbons and ozone in the atmosphere (7); the exact chemistry of the phytotoxic products is unknown.

Through the courtesy of F. W. Went of the California Institute of Technology, plants were grown smog-free in the specially filtered greenhouses of Earhart Laboratory (8). Smog damage has been duplicated experimentally in the laboratory at Air Pollution Control District headquarters by subjecting normal plants to the reaction products of ozone and gasoline vapors (9). The living plant cell appears to be an excellent biological indicator for smog, and annual bluegrass, *Poa annua* (L.), has been singled out as one of the most sensitive plants yet observed.

Gross symptoms of smog damage in the field vary with each crop from a permanent water-logged appearance of the leaf undersurface to complete necrosis. In dicotyledons, smog damage may be recognized as "silvery" in spinach, "bronzing" in romaine lettuce, brown-black mottling in tomato, or an increase in anthocyanin in table beet. In monocotyledons, tan banding is the characteristic response in barley and *Poa* (3), and longitudinal streaking in oat (10), corn, and many grasses.

Microscopic examination reveals the nature of histological damage. Most accurate results were obtained by studying fresh leaf material. Damaged cells were readily distinguished by staining thin hand sections with simple microchemical reagents, such as thionin in weak aqueous solution, Sudan III, and Sudan black. Damaged cells took stain readily, whereas normal ones resisted it. Permanent sections were not made, but data were kept by means of microphotographs.

In all plants observed, both monocotyledons and dicotyledons, there is apparent a characteristic progression in smog damage. The first visible response is a shiny, water-logged appearance on the leaf undersurface. The lower epidermis is raised in tiny blisters, produced by the swelling of the epidermal cells closest

to the stomata. At the same time stomatal apertures enlarge as guard cells expand in width. The entire leaf at this time becomes turgid. Actively functioning leaf stomata are considered to be the portals of entry for atmospheric smog, since the cells that line the substomatal chambers show protoplasmic injury first and are always the most severely damaged (11). Chloroplasts disintegrate and plasmolysis follows. Cell walls shrink slowly, maintaining plasmodesmatal connections with neighboring cells. Damage is usually limited to a few cells surrounding the affected substomatal chamber. There is no rupture of cell walls or dissolution of middle lamella. Inter-cellular air spaces enlarge as affected cells shrink. Since dehydration is slow, cellular "mummification" of affected tissue is not complete until 1 to 2 days following exposure (Fig. 1). The extent of tissue involvement is, as in any gas damage, in proportion to the concentration and duration of pollution.

In the grass, *Poa annua* (L), the sensitivity of the leaf tissue is a function of its maturity (3). Damage in the youngest leaf appears only at the tip; in a leaf somewhat older, close to midblade; and in a fully matured leaf, only at the base. This localization of damage has been shown to be related to the gradient of cellular differentiation from tip toward base in the maturing leaves and is probably true also in broad-leaved plants, such as spinach and tobacco, in which cellular maturity is likewise progressive from tip toward base (12, 13). Only the cells that have just completed maximum expansion are smog sensitive. Young leaves are not susceptible, probably by virtue of their compact cellular nature, absence of well-developed intercellular air spaces and substomatal chambers, and nonfunctional stomata. Old leaves are not sensitive by virtue of their comparatively heavily suberized cell walls (14).

Whatever the gross picture of smog damage, anatomical studies indicate that in all sensitive vegetation the microscopic picture is the same. It is evident from this work, that the damage produced by smog differs from that produced by any other phytotoxic agent studied, for example, frost, ozone (15), SO₂, HF, fungus, and insect. Smog-attacked cells are not disrupted as they shrink, resulting in a tissue "skeletonization" in the limited regions of the substomatal chambers; damage in response to other gases is usually unlimited, spreading throughout the lamina and, more often than not, resulting in complete necrosis (SO₂, O₃) or affecting vascular elements (HF) (5). The anatomy of stems and roots and the vascular elements of leaves are never affected by smog, indicating that the phytotoxic constituents of smog are not translocated within the plant.

Poa annua (L) is considered a very reliable biological indicator for atmospheric smog for several reasons: (i) the extreme sensitivity of its cells to minute quantities of phytotoxic materials; (ii) its method of cellular differentiation from tip toward base in the linear leaf with resulting marked transverse leaf banding; and (iii) its ubiquity as a weed

in Los Angeles County, making a naturally occurring check available in many and scattered areas. Work is in progress in an attempt to calibrate this plant as a quantitative, as well as a qualitative, bioassay material. A detailed account of the anatomy of normal and smog damaged *Poa* has been completed.

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21 December 1954.

Contamination of Nuclear Fractions of Thymus Homogenates with Whole Cells

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A reexamination of methods for the isolation of nuclei of cells of the thymus gland of the rat and calf has led to the observation of atypical reactions that suggest a gross contamination with intact whole cells. In view of the recent use of nuclear fractions of thymus homogenates in studies on the localization of enzymes (1, 2), it is desirable to report a method (3) for demonstrating such contamination.

The isolation of a pure nuclear fraction from the thymus gland is complicated by the presence of large numbers of small thymocytes, that is, small cells with large nuclei surrounded by a very thin layer of cytoplasm. Histologically, these cells are indistinguishable from small lymphocytes (4). It is frequently very difficult, if not impossible, to detect contamination of fresh nuclear fractions with these cells by routine examination with the phase contrast microscope, since the layer of cytoplasm is so thin as to be indistinguishable. The difference in reaction of isolated nuclei and whole cells to changes in ionic composition or osmotic pressure of the suspending medium offers a ready means of determining the extent of contamination.

For this study, the nuclear fraction of calf thymus was isolated by the method of Stern and Mirsky (1), which employs a solution of 0.0018M CaCl₂ in ap-

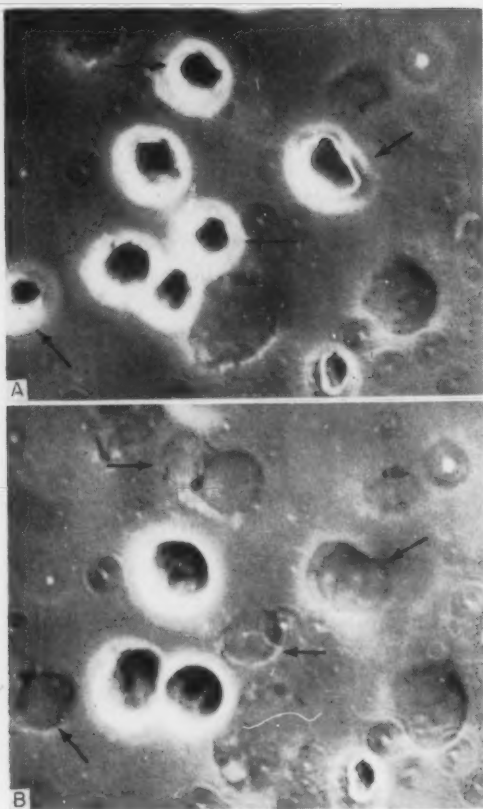


Fig. 1. (A) Photomicrograph of nuclear fraction of calf thymus homogenate 2 min after treatment with alkaline 0.25M sucrose and 1 percent bovine serum albumin. (B) Photomicrograph of the same microscopic field as (A) taken 1 min after treatment with 0.001M CaCl_2 .

proximately 0.25M sucrose as the isolation medium. Examination of the wet preparation with the phase contrast microscope revealed no evidence of contamination with whole cells. A solution of alkaline (pH 8.5) 0.25M sucrose and 1 percent bovine serum albumin was then added at the edge of the cover glass and drawn across the field by absorption of fluid in lens paper at the opposite edge of the cover glass. This

solution causes the disintegration of isolated nuclei, as proved on other preparations. Figures 1A shows the result of this treatment on the nuclear preparation 2 min after adding the test solution. Only a few of the "nuclei" swelled and disintegrated, whereas the remainder were apparently unaffected by this medium. The remaining "nuclei" were then treated with 0.001M CaCl_2 added in the same manner. Figure 1B, which was taken 1 min after adding the 0.001M CaCl_2 solution, shows the same microscopic field as Fig. 1A. Note that some of the "nuclei" have ruptured, discharging their contents into the medium. The remainder show a distinct increase in size. On continued exposure to the hypotonic medium, the remainder of the "nuclei" also rupture.

These observations lead to the conclusion that the "nuclei" that swell in 0.001M CaCl_2 are in reality intact small thymocytes, for it has been shown (5) that, in isolated nuclei of other tissues, hypotonic CaCl_2 causes shrinkage of the isolated nuclei, whereas whole cells swell in hypotonic solution.

The differential action of the alkaline sucrose medium probably is twofold. (i) It has been shown that isolated nuclei do not react osmotically to sucrose solutions but may swell and dissolve in 0.88M sucrose (5). (ii) Alkaline solutions cause swelling and disintegration of isolated nuclei (6). This contamination of the nuclear fraction with whole cells appears to be more pronounced in the preparations isolated in 0.25M sucrose and 0.0018M CaCl_2 than in those mediums containing citric acid, suggesting that pH and ion binding may be important factors in stability of the plasma membrane of small thymocytes. Preparations isolated at low pH, however, are not considered satisfactory for enzyme studies.

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5 January 1955.

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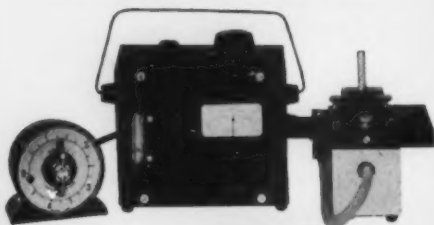
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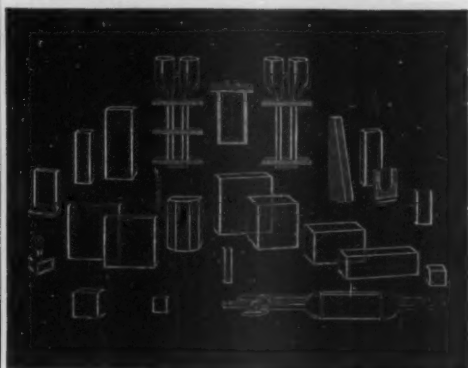


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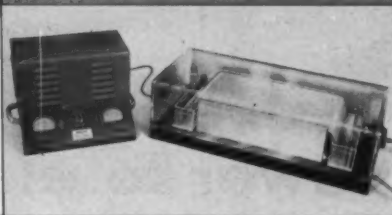
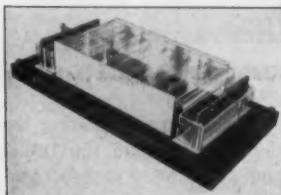
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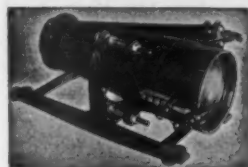
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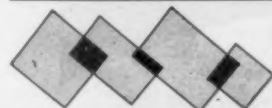
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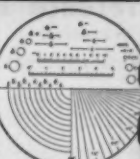
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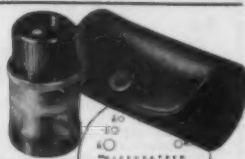
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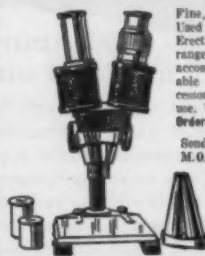
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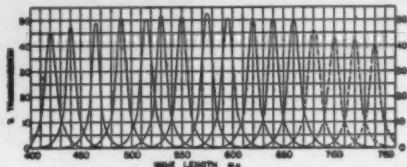
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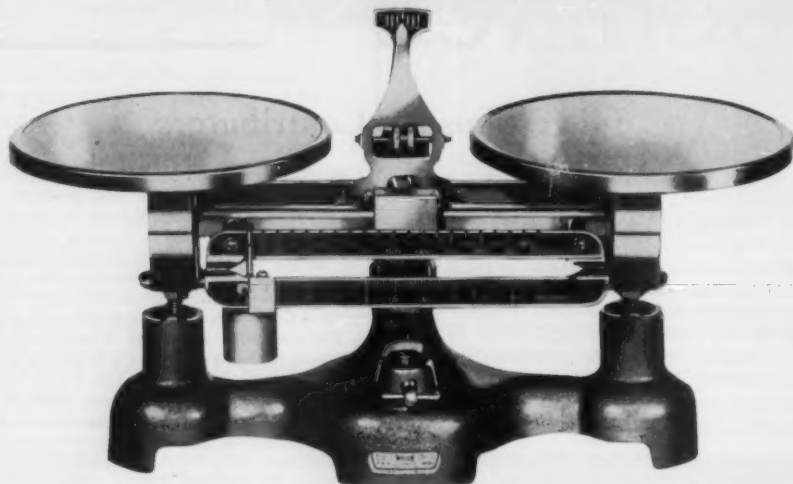
- * Senior research fellow, National Institute of Sciences of India.
- 1. This investigation was supported by a grant from the National Heart Institute. We are indebted to H. Hiral for the Whatman filter paper.
- 2. R. S. Adams and C. E. Watson, *J. Biol. Chem.* **147**, 460 (1943).
- 3. Dicumaryl is the trademark for. . .
- 4. S. H. Aston, *An Introduction to Biochemistry* (Street & Smith, New York, ed. 3, 1948), p. 38.
- 5. White's determination of this factor involves. . .

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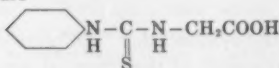
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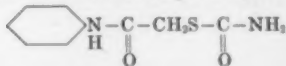
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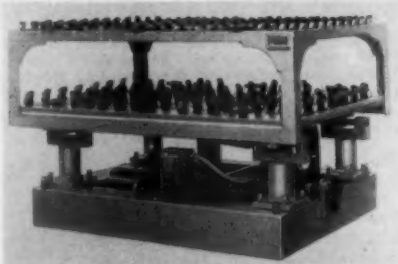
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- 9-13. American Psychiatric Assoc., 111th annual, Atlantic City, N.J. (W. Malamud, 80 E. Concord St., Boston 18, Mass.)
- 12-13. Soc. for Applied Spectroscopy, New York, N.Y. (C. A. Jedlicka, Lucius Pitkin, Inc., 47 Fulton St., New York 38.)
- 12-14. American Assoc. of the History of Medicine, 28th annual, Detroit, Mich. (E. H. Ackerknecht, professor of the history of medicine, Univ. of Wisconsin, Madison 6.)
- 12-14. Virginia Academy of Science, Harrisonburg, Va. (F. F. Smith, VAS, P. O. Box 1420, Richmond.)
- 12-19. Latin-American Cong. of Chemistry, Caracas, Venezuela. (Jose L. Prado, Edificio Industria-Puente Republica, Apartado de Correos No. 3895, Caracas.)
- 13-14. American Physical Soc., New York State Section, Buffalo, N.Y. (L. W. Phillips, Univ. of Buffalo, Buffalo 14.)
- 13-14. American Assoc. for Cleft Palate Rehabilitation, 13th annual, Boston, Mass. (A. Fox, 1653 Main St., Springfield, Mass.)
- 13-15. American Academy of Dental Medicine, 9th annual, New York. (W. M. Greenhut, 124 E. 84 St., New York 28.)
- 14-21. European Federation for Chemical Engineering, Frankfurt A.M., Germany. (Dechema, Frankfurt A.M. W. 13.)
- 16-18. Radiation Research Soc., Hotel New Yorker, New York, N.Y.
- 16-19. American Assoc. of Cereal Chemists, St. Louis, Mo. (C. L. Brooke, Merck and Co., Inc., Rahway, N.J.)
- 16-20. National Conf. on Weights and Measures, 40th, Washington, D.C. (W. S. Bussey, National Bureau of Standards, Washington 25.)
- 18-20. American College of Cardiology, 4th annual, New York, N.Y. (P. Reichert, ACC, 140 W. 57 St., New York 19.)
- 18-20. European Assoc. of Exploration Geophysicists, 8th meeting, Paris. (Dr. B. Baars, 30 Carrel van Bylandtlaan, The Hague.)
- 19. Maryland Acad. of Science, annual, Baltimore, Md. (J. W. Easter, Mt. Vernon Woodberry Mills, Mercantile Trust Bldg., Baltimore 2, Md.)
- 19-20. Soc. of Exploration Geophysicists, 10th annual Gulf Coast meeting, San Antonio, Tex. (SEG, 624 S. Cheyenne, Tulsa, Okla.)
- 23-25. American Trudeau Soc., Milwaukee, Wis. (Natl. Tuberculosis Assoc., 1790 Broadway, New York 19.)

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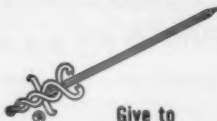
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